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NATIONAL
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in a
MODERN
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NATIONAL STANDARDS in a MODERN ECONOMY

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NATIONAL STANDARDS IN A MODERN ECONOMY

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This volume is dedicated to
PAUL GOUGH AGNEW
Secretary, American Standards Association, 1919-1947,
the man who defined standards in these words:

> In the flow of products from farm, forest, mine, and sea, through processing and fabricating plants, and through wholesale and retail markets to the ultimate consumer, most difficulties are met at transition points—points at which the product passes from department to department within a company, or is sold by one company to another or to an individual. The main function of standards is to facilitate the flow of products through these transition points. Standards are thus both facilitators and integrators. In smoothing out points of difficulty, or "bottlenecks," they provide the evolutionary adjustments which are necessary for industry to be able to keep pace with technical advances. They do this in the individual plant, in particular industries, and in industry at large. They are all the more effective as integrators in that they proceed by simple, evolutionary steps, albeit inconspicuously.

Quoted from "Standardization"
Encyclopedia Britannica
Edition of 1940

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PREFACE

THE PARTNERSHIP between science and standards holds the secret to the extraordinary dynamism and productivity of modern industrial technology. This partnership begins at the laboratory door; it pervades all processes of production; it comes to rest only when the goods are used up in the hands of the ultimate consumer.

The most singular product of this union has been what Alfred North Whitehead, philosopher and mathematician, once termed "the invention of the method of invention." Thence has come the flood of discoveries and new applications which have led some to speak of a "new industrial revolution" in recent times. But in the annals of men this union will be honored because it is opening the doors of material prosperity to all.

The more active and better understood role has been played throughout by science; the more passive and little understood—when not actually misunderstood—role by standards.

On the one hand, science is everywhere honored as the source of knowledge about the material universe and the world of man. It is the discoverer of new materials, new techniques, new products. In a world faced with mounting demands of rapidly growing populations for increased standards of living, science appears as the source of new sources of materials and enhanced productivity such as those provided by the spectacular developments in industrial chemicals, atomic energy, and electronics. Vannevar Bush, in a now memorable pamphlet, has spoken of "science, the endless frontier." The nation has responded with the wherewithal for expansion of this frontier. In the late twenties nearly $100,000 was being spent annually in the United States on research and development. Today the comparable figure runs between $6 and $8 billion. The other great industrial countries are following close behind.

Standards, on the other hand, have been but little understood. They stem from the dimly-lit centuries of prehistory with the evolution of rules and practices of language formation and the giving of precise meaning to words. They were applied in industry with the first recognition of clearcut properties of materials—clays, metals, foodstuffs, drugs, etc., and of best processes for obtaining determinable results in the production of objects of use. With the rise of the several sciences in post-medieval times, standards were developed for classification, words, signs, symbols, formulae, methods of representation, units of measurement, techniques of comparison, criteria for verification, etc. Thus was slowly evolved a universal scientific lingua franca, and a system of universally recognized methods for conducting and evaluating research.

The modern standards movement began at the point where efforts were made to systematize this relationship between science and standards on a comprehensive basis. It came in two steps. The first was the founding of great national research institutions dedicated to the tasks of keeping the techniques of measurement and control in step with the advance of science, and of promoting their applications in industry. These institutions were Germany's Imperial Physical-Technical Institute organized in 1887 under the leadership of the great natural scientist van Helmholtz, England's National Physical Laboratory founded in 1900, and our own National Bureau of Standards established the following year. Each one of them has since become a huge series of laboratories carrying on basic research and developing precision measuring techniques to serve both science and industry over the entire range of their problems.

The second great step came with the parallel effort to introduce similar standards into day-by-day industrial practice. The British led with the founding of the British Standards Institution in 1901. Since then every major industrial country and most of the newer underdeveloped countries have established similar national standards institutions for correlating and promoting on a national basis industrially and commercially usable standards. The American counterpart of the British Standards Institution, the American Engineering Standards Committee (now the American Standards Association) was founded in 1918. All these national standards bodies cooperate with one another through the International Organization for Standardization (ISO) in the international sphere, and with the numerous engineering, trade association, company, government, and other standards bodies the work of which supplements and complements their own in the domestic sphere.

Throughout both levels of basic research and of detailed industrial application, the effort is to select the best, most economical, most functionally useful, most safe and reliable materials, processes, methods, sizes, varieties, dimensions, modes of representation, and techniques of control. "Best" means best according to the level of current scientific knowledge and experimentation, and best in terms of the objectively defined functions which need to be performed. This also means best in all cases with particular reference to the further promotion of mass-production methods.

If science is then the great innovator in contemporary society, standardization is the great converter of innovations to practical use. The usefulness of standards runs the gamut of industrial needs on the one hand,

and of the vast bulk of the desires and needs of ultimate consumers on the other. In sum, the role of standards begins with facilitating research; its secret is controlled variation; its triumph is mass production; and its success is the bending of scientific and industrial effort to serve more adequately the expressed needs and wants of all.

No one better understood the ramifications of standardization—the "philosophy of standards" as he used to call it—than Dr. Paul G. Agnew, for 28 years (1919-47) the major guiding hand in the work of the American Standards Association. After his death in 1954 it was decided to seize the occasion to reassess the full implications of his "philosophy of standards," and to convey to the interested public from top management to the ultimate consumers some understanding of how the standards movement which he did so much to promote has already begun to affect the scale and quality of their material welfare, and alter the general course of life.

It is especially important that the full meaning of industrial standardization be properly understood at the present time. Not only does the United States seem to be in the midst of a "new industrial revolution"; but also its spectacular increases in national productivity and its consequent vastly expanded material levels of consumption have become the wonder of the world. Foreign delegations by the score have been visiting these shores. Better than sixty special productivity teams of experts have come from Britain alone since World War II. Meanwhile American expertise is being sought in the most distant lands.

In memory of the spirit of Dr. Agnew, the editorial committee has sought out the best qualified experts it could find to write a series of authoritative articles on various phases and aspects of the standards movement. The authors who contributed to the volume gave freely of their time, energy, experience, and knowledge, and present here the first attempt that has ever been made to examine and assess the standards movement as a whole within the United States.

The volume is a joint undertaking of the Standardization Fellowship, sustained by the Sarah Mellon Scaife Foundation at Mellon Institute of Industrial Research in Pittsburgh, and the American Standards Association.

The generous financial support of the Foundation made it possible to plan the volume and to carry out the major portion of editing and preparing the manuscript in its final form. A special grant from the Foundation assured publication of the volume.

The staff of the American Standards Association contributed liberally to the editorial work and opened the Association's files for innumerable references to fact and history, many of them unobtainable from any other source.

The manifold tasks connected with the planning and readying of the manuscript for the publishers were done with the valued assistance of the Director and Staff of the Bureau of Business and Economic Research at the University of California in Berkeley, where parts of the Standardization Fellowship's program are carried on.

DICKSON RECK
Editor
ROBERT A. BRADY
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EDWARD R. WEIDLIEN
Editorial Advisory Board

PART I

The Movement Toward National and International Standards

1. THE CRUSADE FOR STANDARDS

THE HONORABLE HERBERT HOOVER

Former President Hoover's remarks were made at the Second Annual Standardization Conference of the American Standards Association upon acceptance of the Howard Coonley Medal. They are printed here with Mr. Hoover's permission.

A FEW DAYS ago your committee invited me to accept this great honor. And I prize it, especially as it comes from my fellow engineers.

At once my mind traveled back to the years 1921-28 when I was Secretary of Commerce and we all cooperated in a great crusade for the ideas you represent.

Many people probably even now do not appreciate in full the ideas which are embraced in your title of standardization and its subsidiaries, simplification and specification. Yet the philosophies behind these terms and the consequences of their application have played an enormous part in our whole economic development.

At that time the humorists sought to drown us in laughter over possible standardized women's hats. But in time we managed to sustain the conviction that we were wholly allergic to matters of style, for those vagaries were offspring of joy, not of engineering. But we even helped to cheapen some hats by way of simplifying and standardizing parts in the milliners' machinery.

The ideas in our particular philosophy were concerned strictly with industrial products. Herein were standards of weights, measures, voltages, frequencies, heat, screw threads, spare parts, and what not. They included turbine generators, the parts of machine tools, automobiles, farm machinery, and hundreds of others.

Simplifications were concerned with eliminating unnecessary varieties and dimensions in such sordid things as fish plates, bricks, lumber, lamp sockets, automobile wheels, bolts, nuts, plumbers' fittings, and a million other things.

And we were concerned with writing specifications which would assure the consumer quality and performance. This catalogish statement, however, conveys no indication of their importance in our whole economic development. The public mostly assumes that this progress has come from scientific discovery of natural laws, new materials, inventions, and increasing skills. But you and I know that the increase in our living standards and comfort has received an enormous contribution from these related ideas of standards, of simplifications and specifications.

They are at the base of all mass production. They make possible more continuous employment by manufacture for stock instead of dependence upon immediate and specialized orders. They have made it possible to conduct this fabulous productive machine with the least amount of spare parts and inventories in the hands of the consumer industries. They have sharpened competition. They have cheapened the cost of production in millions of directions. Thus they have been a factor in our rising living standards. They have enabled thousands of different articles to be placed within the reach of everybody. They do not impose uniformity on the individual, because they make available to him an infinite variety of additions to his living.

This technology and its blessings reach unheralded into every household, not into industry alone. Before you set to work, the housewife had to shop for special electric lamps that would fit her sockets, for special needles for her sewing machine. At one time she had to trim the bedstead or the springs or the mattress to make them fit with each other. But now they all fit, no matter what the breed. The workman at one time had to find a bolt of the same maker before he could screw a nut on it and had to search among a hundred different diameters. Now the half-inch nuts screw onto all the half-inch bolts and there are but two score of different diameters instead of two hundred. And the common man should be grateful that the three-score sizes of automobile wheels and tires have been replaced by about half a dozen standard sizes.

And the sum total of all these ideas has contributed to making thousands of machines which have lifted the burden from the backs of men and women.

This work of your Association has brought another invaluable accomplishment. Only a few of the literally tens of thousands of standardizations or simplifications have been imposed by law. The vast numbers of them have been the result of spontaneous, voluntary, yet organized cooperation within highly individualized industry. To secure general acceptance of any one of them has been tedious at times. But their adoption has been playing a real part in the creation of the cooperation so vital among a free people.

Certainly it is true that the objects of organized society are to assure justice, freedom, respect for the dignity of men and the improvement and security in living. And to this you continue to make a valuable contribution.

2. A MILLION YEARS OF STANDARDS

EDWARD R. WEIDLEIN AND VERA RECK

Dr. Weidlein is President of Mellon Institute of Industrial Research. Mrs. Reck is a Member of the Staff of the Standardization Fellowship, Mellon Institute of Industrial Research.

THE PANORAMA of standards through the ages is vast and impressive, yet fragmentary. The lines of a continuous development of many standards from ancient times can be clearly distinguished; others are faint and broken. Some standards, such as the systems of measures and weights, have a rich history—based on evidence or record, or both—spanning continents and centuries. The history of other standards, for example that of the railroad gauges, is comparatively short and is limited to the countries which pioneered in the building of railroads.

This review attempts no more than a fleeting glance at a few standards here and there in the stream of time, selected some of them because of their extreme antiquity, others because of their great continuous importance to the human race, still others to illustrate the embryonic stages or later development of some feature associated with standards in the modern thinking such as mass production, automation, or manufacturing to close tolerances.

Within the scope of this review it is convenient to look upon the history of standardization as falling into three arbitrarily set and designated phases: the Ancient and Early Industrial Phase which begins with the dawn of the human race; the Modern Industrial Phase ushered in by Eli Whitney and his contemporaries in the United States and abroad at the turn of the nineteenth century; and the overlapping Organizational Phase extending from the latter part of the nineteenth century to the early part of the twentieth, during which were formed the early associations, institutions, and other groups concerned wholly or in part with the development and extension of standards. Later organizational activities are reviewed elsewhere in this volume.

Ancient and Early Industrial Phase

Standards are as old as man. The spoken word, perhaps the oldest standard of all, grew up with him; others slowly developed over the millennia. Standards of behavior, which may antedate even the language, crystallized gradually as folkways and mores, and as patterns of worship. A certain persistent sameness in the things man made with his hands became apparent early. At first his tools and weapons were a stone or a branch which suited his hand and his purpose. Gradually he learned to improve the chance shapes, and eventually to control them. The untold quantities of stone tools and weapons that man produced over many tens of thousands of years are strikingly similar in materials, shapes, and dimensions, for generations of hunters and tillers faithfully copied the arrowhead and the ax of their ancestors. Improvements came with painful slowness and centuries slipped by before they were widely incorporated into new models. Then, sometime in dim prehistory, we find man producing objects of similar dimensions and composition, not one or two at a time, but a great many at once.

During dry seasons in ancient Egypt and Mesopotamia people lifted blocks of dried mud out of the ground as it shrank and cracked. These rough blocks were stacked together as walls for shelter and defense. From this process there were only a few steps—though long and arduous ones—to making sun-dried bricks with the aid of a simple frame. An ancient brickmaker could make perhaps 3000 bricks a day, and, until a frame wore out, produced several thousand bricks of substantially the same dimensions. This may be put down as an incipient form of mass production of a standard item.

Elementary division of labor may have also begun with brickmaking: we have an excellent pictorial account of the process in a fifteenth-century B.C. Egyptian mural, showing some men carrying water, others working the mud, and still others molding the bricks.

Antiquity also furnishes an example of a standard item mass produced in a continuous operation. In Babylonia, as early as 4000 years B.C., it was a custom to seal bundles, jars, and doors by tying them with rope, pressing a lump of wet clay over the knot, and rolling an engraved cylinder of some hard material over the clay. In some cases apparently the impressed clay seals were made and dried separately to be used as labels—perforated and tied to the goods—for proper identification of the owner. It is easy to visualize this label-making as a continuous process, with ever-repeating designs appearing on the wet clay as the cylinder rolled over it.

Pottery making is as venerable an art as brickmaking, taking its origins at the dawn of the human race. It began as a household task, but with the development of settled communities, evolved into a craft, at first practiced by a lone village potter, but eventually passing to large establishments with many workers skilled in different phases of the manufacture producing great numbers of standard vessels. An interesting study of ancient pottery by Kelso and Thorley gives this picture of production of standard pottery in Palestine of the ninth to seventh centuries B.C.

The pottery was made not for ornament but for use. Because of that and because the demand was great, the making of pottery approximated "quantity production" as we understand it. The better Israelite potters had distinct sizes and shapes for their wares, "throwing" pots to a fixed diameter, but the variable factors in the clay, tempers, and firing temperatures caused a certain percentage of variation in the size of finished wares. In the better grades of commercial wares this variation is about 5 per cent. "Indeed, the surprising point is that there is such small variation as there is in sizes, especially when we remember that this work was speed production."[1] As to shape, some of the cooking pots show an uncanny approximation of the same dimension for width and height. Here the maximum variation is again 5 per cent, although the sizes vary from about 5″ to 13″ in diameter. Some cooking pots and water decanters were made in graduated series, with the ratio between widths and heights remaining constant, so that the wares fit into a perfect scale of gradation.

MEASURES AND WEIGHTS

Measures

Standards of measure began at the time man found it necessary to estimate dimensions and distances for construction, and food gathering and producing. He used the standards nature gave him: his digits and limbs. For measuring objects and short distances he employed such units as the breadth of the first joint of the forefinger, the palm, the span of the hand, the length of the foot, the forearm, and the distance between the tips of the fingers with arms outstretched. For longer distances his measures were "a day's journey" and a pace. These standards became integrated into a great many systems of measures which persist to the present day; in their original form, they are still widely used in many parts of the world. As refinements became necessary, other natural measures were brought into play. From India comes an interesting example of a system of fine measuring units current as late as the seventh century A.D.: a barleycorn, a louse, a nit, a dust grain, a cow's hair, a sheep's hair, a hare's down, a small grain of dust. The last is "divided sevenfold till we come to an excessively small grain of dust (anu); this cannot be divided further without arriving at nothingness, and so it is called the infinitely small. . . ."[2]

The basic natural measures eventually crystallized into fixed standards for certain localities and areas. Rulers and standard containers came into use and gradually gained general acceptance. They were made of a variety of materials, some perishable like wood, others durable like stone. It is to the latter that we owe our direct knowledge of very early standards of measures and weights. Among the oldest existing standards of measures are fragments of Egyptian rulers made of basalt, some of them with divisions accurate to within 0.5″, and dating back to the third millennium B.C. There is also an excellent record—in the form of a mural painting made about 3000 B.C.—of two series of Egyptian capacity measures for grain, wine, and oil, each consisting of fourteen standard containers in binary progression.

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[1] J. L. Kelso and J. P. Thorley, "The Potter's Technique at Tell Beit Mirsim, Particularly in Stratum A," *The Annual of the American Schools of Oriental Research,* Vols. 21-22 (New Haven: Yale University Press, 1941-43), p. 120.

[2] Samuel Beal, *Su-Yu-Ki, Buddist Records of the Western World* (Boston: J. R. Osgood and Company, 1885), p. 71.

Weights

The need to weigh came much later than the need to measure. Historians tell us that the balance was first used for weighing precious metals for temple use, or for the king and his governors. In Egypt at least, volume measurements sufficed for commercial transactions until about the fifteenth or fourteenth century B.C. when the balance was adopted for trade. The earliest man-made weights which came down to us are cylindrical stone ones belonging to the archaic "beqa" system of Egypt, and dating from about 7000 B.C.[3] This is perhaps the oldest existing material standard in the world.

Maintenance of Standards

The problem faced by the rulers and governments of maintaining accurate standards of measures and weights has been with us for several thousands of years. In ancient Babylonia, sometime between 2400 and 2350 B.C., King Dungi (called Shulgi by some authorities) introduced a uniform standard of weights and made provisions for maintaining it by establishing an official testing-house in his capital where the original standards were preserved and where copies were tested and certified as accurate. The testing-house was probably attached to a temple and was under the direction of the priests.[4] In Egypt public weighers ascertained the correct amounts of goods bought and sold, and reference measures were cut on the stone walls of temples. In Athens public standards were maintained for checking not only the Athenian weights but also the Persian and Phoenician for the Greek maritime trade. In Rome and the conquered territories reference standards were generally used. Several centuries after Rome, William the Conqueror decreed that weights and measures be "duly certified, just exactly as the good predecessors have appointed," indicating a practice of long standing and foretelling its long continuance.

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[3] "Weights and Weighing," *Chambers's Encyclopaedia*, Vol. XIV (New York: Oxford University Press, 1950), p. 498.

[4] Leonard King, *A History of Sumer and Akkad* (New York: Frederick A. Stokes Company), p. 295.

The concern of the rulers and governments with the accuracy of measures and weights expressed itself particularly sharply in connection with taxation in kind. Were the government tax collectors getting the full due measures of barley, honey, or olive oil? The question undoubtedly vexed many a government official since the beginning of taxes. There is evidence that in ancient Palestine, for example, government-owned potteries produced quantities of standard vessels, appropriately stamped and certified as legal containers for paying taxes in kind. In the Arab Empire in the eighth and ninth centuries A.D. certification of vessels for tax collection appears to have been developed to a fine point: cups and bowls were stamped as official measures of volume (or sometimes of weight), certified to be up to legal standards by the governor or finance director through his prefect, who had under his administration the Bureau of Standards, a branch of the Treasury. The legends which appear on the stamps indicate series of measures and refer to numerous commodities, most of them used for paying taxes.[5]

The Origins of Today's Systems

The foundations of our foot and pound system were laid in 1266 by Henry III of England, who defined the coinage and commercial pound in terms of the English penny which was to weigh "32 grains of wheat taken from the middle of the ear," and in 1305 by Edward I, who set a primary standard of measure: three grains of barley, dry and round, laid end to end make an inch.

The metric system, a decimal system based on the meter, which was originally intended to be one ten-millionth of a meridional quadrant of the earth, was legalized in France in 1795. It was brought to the attention of the Congress of the United States by President Washington in the same year, but was rejected. Following the Civil War, in 1866, an act was passed making it "lawful throughout the United States of America" to employ the system, and defining the meter in terms of inches. In the interim, however, the Troy pound was legalized for coinage, and the Treasury Department imported prototype foot and pound standards from England for use in custom houses. In addition to the Troy pound, the only legalized prototype standards in the United States are the meter and kilogram supplied to our government by the Metric Convention of 1875. Since 1893, when in the absence of congressional action, the Superintendent of the Coast and Geodetic Survey declared the metric prototypes "fundamental standards," our customary units, the yard and the pound, have been derived from them.

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[5] George C. Miles, *Early Arabic Glass Weights and Stamps* (New York: The American Numismatic Society, 1948), p. 19.

MOVABLE TYPE

The invention of movable type in China foreshadowed a new era in the history of standardization: it created a need for precision and minute tolerances in quantity production of standard items, and it pointed the way to a great manufacturing development of another age—the production of interchangeable parts.

The invention, which bears a direct relation to the older process of printing from wood blocks cut in relief—a block for each page—was made sometime between 1041 and 1049 A.D. We have an excellent description of the new way of printing by a reliable contemporary writer. According to him, the characters were cut in low relief on separate blocks of clay, which were then baked. The page was set by fitting together the proper characters and carefully aligning them face up within an iron frame resting upon an iron plate coated with paste capable of being softened by heat. When the paste was properly softened, a very smooth board was pressed against the type, making it perfectly even and ready for printing.[6] Later Chinese type founders experimented with metal and wooden type, but it was the Koreans to whom belongs the honor of developing to a high degree the art of casting type in molds in the early fifteenth century and probably earlier. At that time hundreds of thousands of types were in existence in Korea and it was possible to print "more than forty sheets a day."[7]

Since Chinese and Korean writing is based on several thousand separate symbols, printing with movable type has seldom been practical or economical in China until modern times; in Korea it flourished only under the imperial patronage. In Europe, on the other hand, where movable type was invented, apparently independently, about 400 years later, the reverse has been true: for languages based on alphabet, with the same letter recurring in countless combinations, it offered great savings in labor and costs. European type casters went through similar phases of experimentation as did their Chinese and Korean predecessors, and in the latter part of the fifteenth century were using type composed of lead, tin, and antimony, cast in brass molds.[8] There was a significant technical difference between the metal type of Korea and Europe. Whereas Korean type was roughly finished and required some mechanical device, such as a plate of wax or a rod-and-groove arrangement to keep the alignment, European type was so uniform and so precisely fashioned as to lock together naturally into a solid printing surface. The individual components of the surface were, of course, the interchangeable parts taken at random from the font and fitted, without any adjustment, into their appropriate places. Thus type founding in Europe became one of the first industries producing standard items of precise shapes and dimensions capable of being used interchangeably.

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[6] Thomas Francis Carter, *The Invention of Printing in China and Its Spread Westward,* 2nd ed. (New York: The Ronald Press Company, 1955), p. 212.

[7] *Ibid.*, p. 227.

[8] William Barclay Parsons, *Engineers and Engineering in the Renaissance* (Baltimore: The Williams and Wilkins Company, 1939), p. 107.

ARMS AND SHIPS

It is a fair conjecture that military men had been concerned with standardization of weapons and equipment long before the Arsenal of Venice issued an order in the fourteenth century that all bows were to be made so that the arrows would fit any of them. With spreading adoption of firearms in the fourteenth and fifteenth centuries the problem of standardizing the weapons became more pressing. Handbooks on gunmaking which showed clearly how to construct standard guns made their appearance, and army men began to regard with disfavor any gun of unique design, with parts which would not interchange with those of other guns. Of course, interchangeability of parts in the firearms industry at that time meant little more than effective salvage and reuse of parts with only minor adjustments; nevertheless it was important. By the late fifteenth century, cast-iron shot and field guns of cast iron and bronze were fairly well standardized, and in the first half of the sixteenth century assessment standards were developed for artillery and hand guns: the former were classified by the weight of the cannon ball that they fired, giving rise to the terms "ten-pounder," "twenty-pounder," etc., and the latter by the number of bullets contained in a pound. A system of classifying guns according to standard bores was developed in 1540.

About the time when the printing industry was engaged in interchangeable parts manufacture with increasing precision, the principle—in an extremely broad sense and with crudest tolerances—was also applied to the construction of galleys at the Arsenal of Venice. The results astounded contemporary observers, one of whom, a monk who traveled in a galley to the Holy Land in 1483, wrote: "Now, all galleys of the same size are so much alike in all respects that a man who passes from his own galley on board of another would hardly find out that he was on another, except from the officers and crews of the vessels being different, for Venetian galleys are as like one to another as swallows' nests."[9]

This uniformity was achieved through standardization and something approaching an assembly line in the final stages of equipping the galleys. After the hull was constructed, the work on the ship came to be more and more an assemblage of parts made at the Arsenal or at independent shops specializing in the making of pulleys, masts, spars, rudders, anchors, etc. Finally, the galley was towed along a canal on the banks of which were workshops and warehouses stocked with cordage, oars, sails, deck furnishings, food, arms, and all the other necessary things. As the galley passed each shop or storeroom, equipment and supplies were loaded on board, and by the time the galley reached the end of the line she was equipped from stem to stern. All this was accomplished with the greatest expedition. Although the story that the Venetians built and launched a galley while Henry III of France was at dinner may be apocryphal, at least the final stages of equipping a galley took mere hours.

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[9] Frederic Chapin Lane, *Venetian Ships and Shipbuilders of the Renaissance* (Baltimore: Johns Hopkins Press, 1934), p. 17.

The idea of interchangeable parts manufacture was enunciated clearly by the anonymous author of *Considerations of the East India Trade,* published in 1701. He cited the example of the Dutch who were constructing fishing busses of the same model, "so that the parts of one wou'd serve for every Buss," and suggested the following remedy for the lamentable state of the British shipping: construction by cheap labor in the plantations of "Rudders, Masts and Keels, and other Parts of Ships of any one kind, already fitted to certain Sizes and Dimensions."

COINAGE AND TEXTILE MACHINERY

Seventeenth-century Europe brought to the fore an idea which fascinated the observers and frightened those immediately concerned. That idea was production of standard objects by a completely automatic process. The two examples of the application of the idea cited below are by not altogether reliable reporters. Nevertheless, while the extent to which the principle was actually put to use remains uncertain, there is no doubt that the notion of producing goods entirely by machinery, without any "humane help," was well developed and regarded as practical.

The first report by Sir Kenelm Digby, an adventurer and writer, describes the automatic mint at Segovia which Sir Kenelm saw as a young boy in 1617. The water-powered "engine," says the reporter, is so artfully made

> that one part of it distends an Ingot of Silver or Gold, into that breadth and thickness as is requisite to make Coyn of. Which being done, it delivers the plate it has wrought to another, that Prints the Figure of the Coyn upon it. And from thence it is turn'd over to another, that cuts it according to the Print, into due shape and weight. And lastly, the several pieces fall into a reserve, in another room: where the Officer, whose charge it is, finds Treasure ready Coyned; without any thing there, to inform him of the several different motions that the silver or the gold passed, before they came to that state. But, if he go on the other side of the wall, into the room where the other machines stand and are at work; he will then discern that every one of them, which consider'd by it self might seem a distinct complete engine, is but a serving part of the whole, whose office is to make money: and that, for this work any one

> of them, separated from the rest, ceases to be the part of a mint, and the whole is maim'd and destroy'd.[10]

The other report, in its third retelling, was published by Thomas Powell in 1661 in his work *Humane Industry of Most Manual Arts.* It tells of a "rare invention" in Dantzick, Poland, "for weaving of 4 or five Webs at a time without any humane help; it was an *Automaton* or Engine that moved of it self and would work night and day." The invention was suppressed and the inventor done away with secretly, presumably by the weavers whose livelihood was threatened.

Modern Industrial Phase

MUSKETS AND RIFLES

With Eli Whitney, the inventor of the cotton gin and the manufacturer of firearms, begins a new phase in the history of standards in the United States. The idea of interchangeable parts manufacture, with the consequently possible division of labor and mass production in the modern sense, which Whitney applied to the execution of the government's huge orders for muskets, was by no means new in his time, even in its application to the manufacture of guns. In France, Lablanc, a contemporary of Whitney's, had made guns with parts to interchange. He devised tools which "abridged" the work, thus cutting down the labor cost and the price of the final product. Lablanc's work, however, excited no interest in France, and never passed the stage of sample-making. Whitney's contribution lies in his practical treatment of the idea: he perceived that production of standard parts with the aid of special machines which in part replaced the skills of the workers held the answer to America's shortage of skilled labor on the one hand, and her great need for arms on the other; and he reduced the idea to practical manufacturing. The latter he did not do alone. A great many men—mechanics in the government armories, contractors, and government officials in Washington—worked long and painstakingly with Whitney to smooth out the path for the new way of making guns.

From the historic event in January 1801 when Whitney took some samples of his muskets to Washington and demonstrated to Thomas Jefferson and several other government officials that the various parts of the locks were interchangeable, almost a quarter of a century was to elapse before all the major problems of design and production were solved and the system was workable in all its details. The year 1824 was the year of accomplishment. It was then that 100 Hall rifles were stripped and remounted, the parts coming together well:

> The joints were not close, nor was the work fine, but the interchangeability was a practical fact, and uniformity was approached on a more sustained

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[10] Sir Kenelm Digby, *Of Bodies* (London, 1669), pp. 257-8.

plan than that of merely filing to jigs or patterns. The joint of the breech-lock was so fitted that a sheet of paper would slide loosely in the joint, but two sheets would stick.[11]

The developments which preceded the notable demonstration of 1824 were momentous in themselves. Perhaps the most important of all was that standards set at Whitney's factory passed the boundaries of his establishment and became the common working basis of all the establishments making guns for the government. This was in effect the beginning of national standardization in modern American industry. Another vitally important innovation was in design: Whitney and the superintendents of the government armories, who began developing a standard musket about 1815, tried to devise the parts in such a way that, within the severe limitations imposed by the form and function of musket construction, they would be suited to mass production. Several years later John H. Hall scrapped the musket and built a model of a rifle, the parts of which were especially designed for machine production.

Precision became the byword of industry in the United States, as well as in England and on the Continent. Tolerances were shrinking to 1/32″ and better, and gauges came into use in the industry. With the rise of watchmaking, and later, sewing machine production, tolerances took another plunge, opening the way for really spectacular developments in the latter part of the nineteenth century.

MILLING MACHINERY

The idea of automatic manufacture was neither new nor entirely neglected in Whitney's time. Whitney himself must have considered it at least possible if not feasible, as is clear from the following excerpt from a letter he wrote in 1799 to Oliver Wolcott, then Secretary of the Treasury, concerning his first contract to supply muskets to the government:

> My general plan does not consist of one great complicated machine, wherever one small part being out of order or not answering to the purpose expected, the whole must stop & be considered useless. If the mode in which I propose to make one part of the musket should prove by experiment not to answer, it will in no way affect my mode of making any other part.[12]

At the time Whitney wrote his letter, the principle of automatic processing was in application in the milling industry in Baltimore. Almost fifteen years earlier Oliver Evans introduced a radical improvement in the industry which heretofore had depended on hand labor to carry out its separate processes. Evans combined the different steps of milling the grain into a continuous operation by means of conveyers, elevators, and other mechanisms. He claimed in his book on milling that the process by which the grain is transformed into fine flour could be completed "from the wagon to the wagon again, without manual labour, except in packing the flour and rolling it in."[13] By manual labor Evans probably meant heavy work like shoveling grain, for it appears from the text and the illustrations that human controls were employed at various strategic points in the mill.

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[11] Charles H. Fitch, "Interchangeable Mechanism," *Report on the Manufactures of the United States at the Tenth Census*, June 1, 1880.

[12] Jeannette Mirsky and Allan Nevins, *The World of Eli Whitney* (New York: The Macmillan Company, 1952), p. 201.

SCREW THREADS

The first organized attempt in the United States to develop a standard screw thread—possibly the most important single engineering standard and the first one achieved through cooperative efforts of mechanics, engineers, and businessmen—may be said to have begun with a paper read by William Sellers at the Franklin Institute in Philadelphia on April 21, 1864. In his paper Sellers acknowledged that the English engineers were far in advance of their American colleagues in adopting a uniform system of screw threads, and added, "it would seem desirable that the system which they have adopted would also be employed by us, unless grave objections can be urged against it, and a better one substituted."

The English were indeed ahead of the Americans in developing standard screw threads. The idea had been fermenting, with some notable practical results, for decades before Joseph Whitworth's historic communication to the Institution of Civil Engineers in 1841, in which he described what later became known as the Whitworth system and which marked the official beginning of screw thread standardization in England. The unification of which Sellers spoke, and which could have been accomplished relatively easily at that time, was delayed eighty-four years at incalculable costs to both nations.

The system proposed by Sellers in his paper differed from Whitworth's in these respects: the sizes and pitches represented the "fair average" of American practice, and were more complete; the crests and roots of the threads were flat, instead of rounded, and the angle of their sides was 60° instead of 55°. The new system was studied by a special committee at the Franklin Institute, and endorsed on December 15, 1864. The committee took steps to spread the knowledge of the new standard as widely as possible, and within a decade the standard was accepted by the engineers of the Army and Navy, by the Master Mechanics Association and by the Master Car-Builders Association. The railroads were the strongest supporters of the standard because, among other things, the practice of exchanging cars from one road to another was growing, and interchangeability of bolts and nuts for repairs of "foreign" cars was becoming increasingly important.

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[13] Oliver Evans, *The Young Mill-Wright and Miller's Guide*, 13th ed. (Philadelphia: Lea and Blanchard, 1850), p. 218.

Although from the beginning there was general agreement that the Sellers system pointed the way out of the chaos of specially designed screws, improvement was slow in coming. At the annual convention of the Master Car-Builders Association in June 1882, a special committee which had been at work for several years investigating the "present construction of screws and nuts used in cars" reported on the slowness of the adoption of the standard. One of the difficulties was the widespread assumption that the Sellers system meant simply a standard for the number of threads to the inch, whereas actually there were other essential features without which the whole system had no existence. An even more serious impediment was lack of basic standards, not to mention accurate measuring devices. "Standard" screws and nuts from different manufacturers and railroad repair shops failed to interchange because gauges used in the making of taps and dies differed significantly. Certain manufacturing customs, such as rolling round iron to larger than nominal diameters, so that bolts cut from it were oversize, also played their part in holding back progress.

There was, of course, the inevitable quota of die-hards who tried to hold customers by retaining distinctive screws, and even some of the large manufacturers of bolts and nuts for many years produced those of standard design only on special orders. Many engineers and practical men, however, worked to eliminate these drawbacks to a wide adoption of standard screw threads, and progress was steady though slow.

With the development of machine design and manufacture in the United States, a need arose for additional screw thread standards, especially for smaller sizes and finer pitches. At this point, about the turn of the century, the leadership in the development and promotion of screw thread standards passed from the railroads to the various technical societies, the National Bureau of Standards, and the manufacturers of specialized threaded products. The needed standards for smaller screws were devised by the Society of Automotive Engineers and the American Society of Mechanical Engineers.

During World War I, poor mating of screws and nuts manufactured in different plants still plagued the industry and the armed forces. As a result, the United States Congress authorized in 1918 the appointment of a National Screw Thread Commission which was directed to "ascertain and establish" standards for screw threads to be adopted in all plants under the Army and Navy control and, so far as practicable, in procurement specifications for these departments. In 1919 the Commission conferred with the British and French standards organizations relative to possible international standardization of screw threads.

The American Standards Association Sectional Committee of Standardization and Unification of Screw Threads, B1, was organized in 1920. This committee cooperated with the National Screw Thread Commission in developing the national Screw Thread Standard, the first edition of which was published in 1924. The Commission was allowed to expire in 1933, but the need for it remained. After a lapse of six years, with the threat of war upon us, it was succeeded by the Interdepartmental Screw Thread Committee established by the Departments of War, Navy, and Commerce. This committee develops the standard specifications for screw threads in products made for the government, and cooperates with the ASA Committee B1 which represents private industry.

A most important step in the development of screw thread standards took place in Washington, on November 18, 1948, when, after lengthy negotiations, representatives of the United States, Great Britain, and Canada signed a Declaration of Accord with respect to the unification of screw threads, and agreed to cooperate in the development and extension of these standards.

Organizational Phase

INTERNATIONAL

The Franklin Institute, the seat of the first stirrings of the standardization movement in the United States, was an organization of men with scientific inclinations and extremely diversified interests. It was, of course, in no wise a standards organization, but because of its strong concern with the mechanical and engineering sciences, it was a suitable forum, if not the only one, to which to bring the pressing problem of screw thread standardization.

National organizations, devoted entirely or largely to the development of standards were still in the future when Sellers made his proposal at the Institute, but on the international scene the organizational movement was already gaining momentum. In 1863 an international meeting was held in Paris, at which the foundations were laid for the improvement of postal relations among different states, principally through agreements on certain standards. Eleven years later, at a congress held in Berne, representatives of all the European nations, the United States, and Egypt formed a General Postal Union, subsequently renamed Universal Postal Union, and signed the International Postal Convention—the first general agreement standardizing and simplifying international postal rates. Both the convention and the formation of the Union became effective in 1875, and today, for all practical purposes, the entire world is a single postal territory for the reciprocal exchange of correspondence.

The year 1875 marks also the official beginning of the International

Bureau of Weights and Measures, an organization concerned wholly with basic standards, and serving many nations. In May of that year, seventeen nations, including the United States, met in Paris at a diplomatic conference and signed the Metric Convention which created the Bureau. At the time, as a result of several international meetings which had taken place in the late 1860's and 1870's at the initiative of the French Government, preliminary work on the construction of new prototypes of the metric standards was in progress. It was the need to preserve and verify these new standards that prompted the formation of the Bureau. The exacting tasks assigned to it were: comparison and verification of the new prototypes of the meter and the kilogram; custody of the international prototypes; periodical comparison of the national metric and non-metric standards with the international prototypes, as well as comparison of standard thermometers; the sealing and comparison of geodesic measuring-bars; and comparison of standards and scales of precision for governments, societies, and individuals. Additional duties, in keeping with the developments in the science of metrology, were assigned to the Bureau by the amended Convention of 1921. The member-states, today numbering thirty-three, constitute the General Conference of Weights and Measures, which governs the Bureau through its executive organ, the International Committee, and which is the ultimate authority on international weights and measures.

Still another pioneer among the international organizations concerned with the development of standards was the International Telegraphic Union, later absorbed in the International Telecommunication Union, founded in 1865. The original purpose of the Union was to write international telegraphic regulations, but with the development of communications, similar functions in regard to telephone and radio devolved upon it.

In the final decades of the nineteenth century and the early years of the twentieth, several international organizations with strong interests in standards sprang up from the fertile soil of advancing technology and expanding industry. The railroads, which had been in the forefront of the standardization movement on their home grounds, formed several international organizations in the 1880's and later, with a view to adopting standards applicable in all the member countries. These common standards embraced technical uniformity of railroads, as well as standard rules, forms, and procedures in matters relating to international railroad transport.

In 1895, after over a decade of informal meetings, a group of workers in experimental engineering organized the International Association for Testing Materials, with the object, among others, of developing and unifying standard methods of testing. Two commissions with important standards programs, the International Electrotechnical Commission and the International Commission on Illumination (the latter succeeding the

International Commission of Photometry founded in 1900) came into official existence in 1904 and 1913 respectively.

NATIONAL

In this country in the latter part of the nineteenth century the major portion of standards work was done by companies in relation to their own production and other problems. On the intercompany level of standardization railroads continued as leaders. Several associations of railroads and of railroad technicians were striving to bring uniformity to the tracks, the rolling stock, and the operations of the lines. Their activities were as often political as technical. A notable achievement in which the government of the United States played a crucial part was standardization of the track gauge at 4′ 8½″. In the act relative to the Union Pacific Railroad Company, July 1, 1862, Congress specified that the track of "the entire line of railroad and branches shall be of uniform width to be determined by the President of the United States." President Lincoln decided that the track should be 5′ wide and issued an executive order to that effect. The decision caused worsening of the political storm brewing about the question of standard gauge, and the controversy went back to Congress. On March 3, 1863, by an act of national legislation the gauge for the Union Pacific Railroad was set at 4′ 8½″. At the time there were nearly two score different gauges represented by the railroads in the United States. With the new standard clearly the gauge of the future, conversion began at once, and although complete practical uniformity was not achieved until June 1, 1886 ("the day of the change" when nearly 14,500 miles of track were converted to standard gauge), in 1870 a passenger train crossed the continent from Boston to San Francisco on tracks of standard gauge.

Within the next twenty years significant progress was made in adopting standard safety couplings, interchangeable air brakes and other items of equipment, as well as standard signalling system, train rules, and accounts. Standard Time came on November 18, 1883. It was a far-reaching and bitterly controversial reform, which was fought over on many grounds, including the political, constitutional, and religious. Individuals and professional societies contributed ideas, plans, and moral support to bringing order out of the chaos of local time reckoning in the United States, but to the railroads' General Time Convention goes the credit for spearheading the adoption of Standard Time throughout the nation.

The closing years of the nineteenth century and the turn of the twentieth witnessed a rising demand for national standards in the industrialized countries of Europe and in the United States. There was a responding acceleration of standards activities on the part of the various engineering societies, which developed standards that were national in effect; but the need for standards far outstripped the facilities to provide them. To narrow the gap, particularly in respect to fundamental standards and precise measuring techniques, the governments of these countries formed organizations charged with the appropriate tasks. In 1887 Germany founded its Imperial Physical-Technical Institute, later renamed with the word "Imperial" replaced by "Federal." England established its National Physical Laboratory in 1900. A year later, the Congress of the United States authorized the formation of the American counterpart of these organizations —the National Bureau of Standards. Similar institutions were established in other countries.

The year 1901 also saw the foundation in England of a private national organization devoted exclusively to the development of standards through cooperative action of scientists, engineers, businessmen, and others. It was the British Standards Institution, the oldest body of its kind in the world, and the model for standards associations in many other countries. The British Standards Institution had an inconspicuous beginning as a committee appointed by the Council of the Institution of Civil Engineers to consider the advisability of standardizing various kinds of iron and steel sections. Representatives of the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Iron and Steel Institute were invited to participate in the work of the group, which as a result, was reconstituted as the Engineering Standards Committee with enlarged terms of reference. One more professional society, the Institution of Electrical Engineers which joined later, completed the number of the "Founder Institutions." Other societies, industrial organizations, and the government were gradually drawn in. In 1918 the Committee was incorporated as the British Engineering Standards Association. In 1929 it received its Royal Charter, and in 1931 its present name. But the character, functions, and aims of the Institution became crystallized within a year or two of its formation: it is "a voluntary body, formed and maintained by industry, approved and supported by the Government, and aiming at the preparation and publication of technical standards"[14] to assist the industrial progress of the nation.

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3. NATIONAL STANDARDS MOVEMENT—ITS EVOLUTION AND FUTURE

COMFORT A. ADAMS

Dr. Adams was first Chairman of the American Engineering Standards Committee, predecessor of the American Standards Association.

THE MODERN STANDARDS movement demands a continuing cooperative effort to bring order into the industrial system, which itself is an outgrowth of slowly evolving basic standards for trade and industry. These standards include language, monetary systems, calendar, systems of measures and weights, and codes of ethics for the conduct of trades, businesses, and professions. Past experience with such fundamental standards has demonstrated the value of certain generally valid principles which should always be employed in standardization. The following are basic and indisputable in all cases:

1. Through universal use of fundamental standards efficiency could be increased both in national and international fields.
2. To ensure a wider use of standards, generous, intelligent cooperation is required from all groups, organizations, and nations concerned.
3. The more fundamental the subject, the greater are the obstacles to agreement on a standard, but also the greater the gains that can be derived from a standard.
4. Progress of civilization depends to a large degree on successful standardization in many fields and on the cooperation necessary to develop standards.

The Past

EARLY STANDARDS

Long before our coordinating organization—The American Standards Association—was founded, many industrial standards had been developed by previously existing agencies. Such agencies included government departments, engineering and other nonprofit societies, trade associations, and individual companies and corporations.

The following are a few of the more significant standards developed before the existence of the ASA:

The present American wire gauge was first proposed by Brown and Sharpe in 1857. It is a rational, geometric progression ratio gauge, generally employed in the United States for copper and other nonferrous electrical conductors.

Standards for screw threads and gear teeth have been through a long evolutionary development, often starting as company standards. For instance, Sellers's screw threads system was employed in his engineering establishment long before he proposed it as a standard in 1864.

The Boiler Code, first issued in 1914 by the Boiler Code Committee of the American Society of Mechanical Engineers, has a unique standing among standards. It has been adopted by most of our industrial states and is enforced by the appropriate state agencies. Moreover, the ASME Boiler Code Committee is handling, on behalf of the ASA, the secretariat of the TC 11 committee on the Unification of Boiler Codes of the International Organization for Standardization.

ENGINEERING SOCIETIES

Before 1918 when the ASA was organized, each engineering society had its own standards committee, or an equivalent, developing its own standards. Some of these standards had national application, but many were used only within a certain industry or area. The American Society for Testing Materials was unique among technical organizations developing standards in that it cut across practically all branches of engineering, working on a horizontal plane in contrast to all other engineering societies which operated vertically within their own special spheres.

My first introduction to standards work dates back to 1910 when I was appointed chairman of the American Institute of Electrical Engineers' Standards Committee, then in its infancy.

One of the most important and difficult problems before the Committee in its early days was the standardization of the ratings of electrical machinery. No agreement existed among the various manufacturers as to what constituted a 10-horsepower motor or a 1000-kilowatt generator. In competitive selling a salesman could claim that a 10-horsepower motor could carry twice that load.

When I was a consulting engineer for a large sugar refinery which used about 400 electric motors, I had all the motors tested at their maximum operating capacity. I found that most of these motors were operating at from 40 to 90 per cent of their official ratings, and a few at more than 100 per cent. Obviously this was an undesirable situation. The wide variation in ratings was one of the major reasons for the organization of the AIEE Standards Committee.

The outcome of our standardizing efforts was a system of ratings based upon specified tests, involving accurate measurements of the temperature rise at the rated load. The method of temperature measurement was accurately specified, and the permissible temperature rise was standardized for each type of insulation.

The development of these standards provided a good example of industrial cooperation. At that time we had no reliable knowledge of the safe operating temperature of the then available types of insulation. To obtain such data, accurate and extensive tests were required. Two members of our standards committee—C. P. Steinmetz of General Electric and B. C. Lamme of Westinghouse Electric—agreed to arrange for the necessary tests to be carried out at the joint expense of the two companies. The results of these tests, published as an AIEE joint paper, still stand as a part of sound and authoritative standards on ratings.

Recently new types of insulation, permitting higher safe operating temperatures, have been developed, and the standards have been revised accordingly. Except for these and other minor changes, the rating standards developed in the early days of the AIEE Standards Committee still hold good as part of our national standards, as well as of the standards developed by the International Electrotechnical Commission.

NATIONAL STANDARDS MOVEMENT

Early in our activities on the AIEE Standards Committee we discovered that several of our electrical standards overlapped and conflicted with the requirements published by other engineering societies. It became obvious to us that it was impossible to separate the various branches of engineering into watertight compartments. If we wanted to assure a general acceptance of our standards, we had to coordinate them with those of other engineering societies.

The first step toward such coordination was taken in 1911 by the American Society of Mechanical Engineers under the leadership of Henry Hess, who proposed a national and international network of Joint Engineering Standards Committees for the "registration" of standards issued by the various technical and industrial groups. The proposal bore no fruit, possibly because it was too advanced for its time.

We attempted informal cooperation with other groups developing standards, but gradually came to the conclusion that a formal organization serving all branches of engineering would be necessary to achieve order on a national basis in the writing and promulgation of standards.

Accordingly, the American Institute of Electrical Engineers took the initiative in calling several preliminary conferences with representatives of other engineering societies. The problem was also brought to the attention of wider circles through discussion in the engineering journals.

After several months of spade work, the AIEE Board of Directors, at its meeting on June 28, 1916, on recommendation of its Standards Committee, voted to invite the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Society for Testing Materials to appoint three members to an organization committee to plan for a national standards organization. The orgnization committee labored nearly two years before an agreement on the constitution and methods of procedure was reached, and recommendations on the formation of what was to be known as the American Engineering Standards Committee were submitted to the five founding societies.

AMERICAN ENGINEERING STANDARDS COMMITTEE

The final meeting of the organization committee at which the AESC was launched took place on October 19, 1918, in the Engineering Societies Building in New York. The same fifteen men who represented the five societies on the organization committee were appointed to the newly-formed AESC, and I was elected chairman, as I had been of the organization committee.

The minutes of the organization meeting contain the following record:

> Mr. Capp moved that the Chairman be designated a committee of one to present invitations to the Department of Commerce, the War Department and the Navy Department to become affiliated with and to participate in the work of the American Engineering Standards Committee with the standing of founders, and to use his endeavor to secure their acceptance of such invitation. Motion seconded and carried.

Through their acceptance of the invitations extended in conformance with the motion, the three federal government departments became founders of the AESC together with the five engineering societies. From the beginning, therefore, the AESC had a quasi-governmental status.

The five original founders each subscribed $1500 a year for the support of the AESC, and C. B. LePage of the American Society of Mechanical Engineers undertook—on a temporary basis—the duties of the Secretary.

One of the first projects of the new committee was the drafting of an extensive program of national industrial safety codes. The codes were to have the power of governmental regulations and, therefore, were of profound concern to the industry. The latter, as represented by trade associations, was willing to cooperate in the drafting of the codes, but insisted also on a voice in the administration of the AESC for itself and the interested governmental agencies and other groups.

Almost the entire first year of the AESC's existence passed in reorganization, and late in 1919 membership was open to trade associations, representatives of the Department of Interior and Agriculture, professional groups, and private companies. It was already obvious that the idea of a national clearing house for engineering standards alone was too narrow and impractical in view of the growing need for national standards in nearly all spheres of economic activity. The AESC's second year began, therefore, with an expanded scope of operations, as well as an enlarged membership. Still another important change took place in December of 1919: the Committee appointed a full-time Secretary. This was Dr. Paul G. Agnew who served loyally and efficiently in that capacity for twenty-eight years—first for the AESC and later for the ASA.

I might mention parenthetically a visit to the United States in 1919 of Mr. Charles le Maistre, then Secretary and later Director of the British Standards Institution. Mr. le Maistre's twenty years' experience in standards work proved invaluable to the organizers of the American national standards agency who consulted him freely. The structure of our technical committees followed closely that used by the British; it is now common for all national standards organizations.

Looking back over the formative years of the AESC in the light of today's attitude toward standards, it is difficult to understand the many obstacles and objections that had to be overcome before true cooperation could be achieved. Our most thorny problem, which cropped up long before the AESC was officially formed and which defied solution for more than a decade afterwards, was that of "sovereignty." Dr. Agnew described the problem aptly as the conflict between the "states' righters" and the "federalists."

Everyone agreed that the purpose of the Committee was to provide a channel of communication and cooperation for the many groups throughout the country which developed standards. How best to accomplish this objective? On this score the opinions were divided. The "states' righters" envisioned the AESC as a purely formal organization assigned almost nominal functions in the development of standards and interfering not one whit with the fundamental tasks of the various societies, associations, and companies. The Committee was to *approve* standards thus giving them "additional strength." The "federalists" countered that such approval would inevitably degenerate into a rubber stamp, and insisted that what was needed was a strong central organization which would play a dynamic role in the development of standards, and give direction to the entire standardization movement. The constitution and rules of procedure offered no guidance in this matter, as by virtue of being drafted in rather general terms, they were susceptible of different interpretations. Less fundamental —but no less vexing—were jurisdictional conflicts and disagreements regarding methods of procedure. Much patience and good will was required to reconcile the opposing points of view and to put the gears of the organization into mesh. This period of stress and contest of ideas lasted through 1921.

In the meantime the technical work of the Committee was well launched. The development of the national industrial safety codes began in earnest in 1920 under the supervision of the Safety Code Correlation Committee, which incidentally served as a model for the present ASA Standards Boards. Other important committees, including those on screw thread, mining, and electrical standards, were among the early technical teams within the AESC. The first American Standard—Pipe Thread, B2-1919 (today B2.1-1945)—was approved in 1919.

The Present

AMERICAN STANDARDS ASSOCIATION

By 1928 it became obvious that the AESC had completely outgrown the committee form of organization, and accordingly, a new constitution and a new name—American Standards Association—were adopted. The transition to the new status stirred up some old differences of opinion. Although certain issues, such as liberalization of methods of procedure, including "autonomous" technical committees and "proprietary sponsorships," were unanimously approved from the beginning.

Under the new constitution a Board of Directors is responsible for policy, administration, and finances, while a Standards Council supervises all technical activities and determines over-all standards policy.

In 1948 the ASA was incorporated in the State of New York, and because of certain legal requirements, the participation of the government representatives was reduced to work on technical committees.

Today the ASA can look back upon years of strong growth and solid achievement. The membership has increased from five engineering societies and three federal government departments to 110 technical organizations with nearly 2300 individual company members, and the number of truly national standards grew from none to 1500 American Standards, including 160 safety codes which form the backbone of governmental regulations for the protection of workmen in almost every industry in the country. In round numbers, 400 standards projects or revisions are currently in the hands of 200 ASA committees with a total membership of 7000 engineers, government officials, and representatives of all national groups which have a stake in standardization.

In general, the ASA does not initiate or write standards. It merely provides the neutral ground and the machinery that permit the development of national standards and approves them as American Standards.

In its activities the ASA is guided by the following fundamental principles:

1. *Scope of Activities.* The ASA has the authority to undertake any standards project which deserves national recognition.

2. *Extent of Projects.* The limits of each project are precisely defined. The project is then broken into parts for easier handling by competent groups.

3. *Consensus Principle.* The first paragraph of the ASA Procedure defines the consensus principle as follows:

> A national standard implies a consensus of those substantially concerned with its scope and provisions. . . . The basic test to be applied in all cases is the fact of the assent, affirmatively expressed, of the groups having substantial concern with the standard. Such groups have an inherent right to representation on the body dealing with the subject-matter of the standard, but it is not essential that this right be exercised.

4. *Flexibility.* The ASA Constitution provides that any method of developing and revising standards is acceptable, so long as it conforms to the consensus principle.

5. *Public Interest and Judicial Methods.* As the national standardizing body, the ASA operates broadly in the public interest and not merely in the interest of its member-bodies. It exercises great care in the selection of its methods.

General, voluntary support of all interested groups is relied upon to make the American Standards effective. As an organization based on voluntary cooperation and democratic principles, the ASA has neither the authority nor the intention to enforce the use of any American Standard.

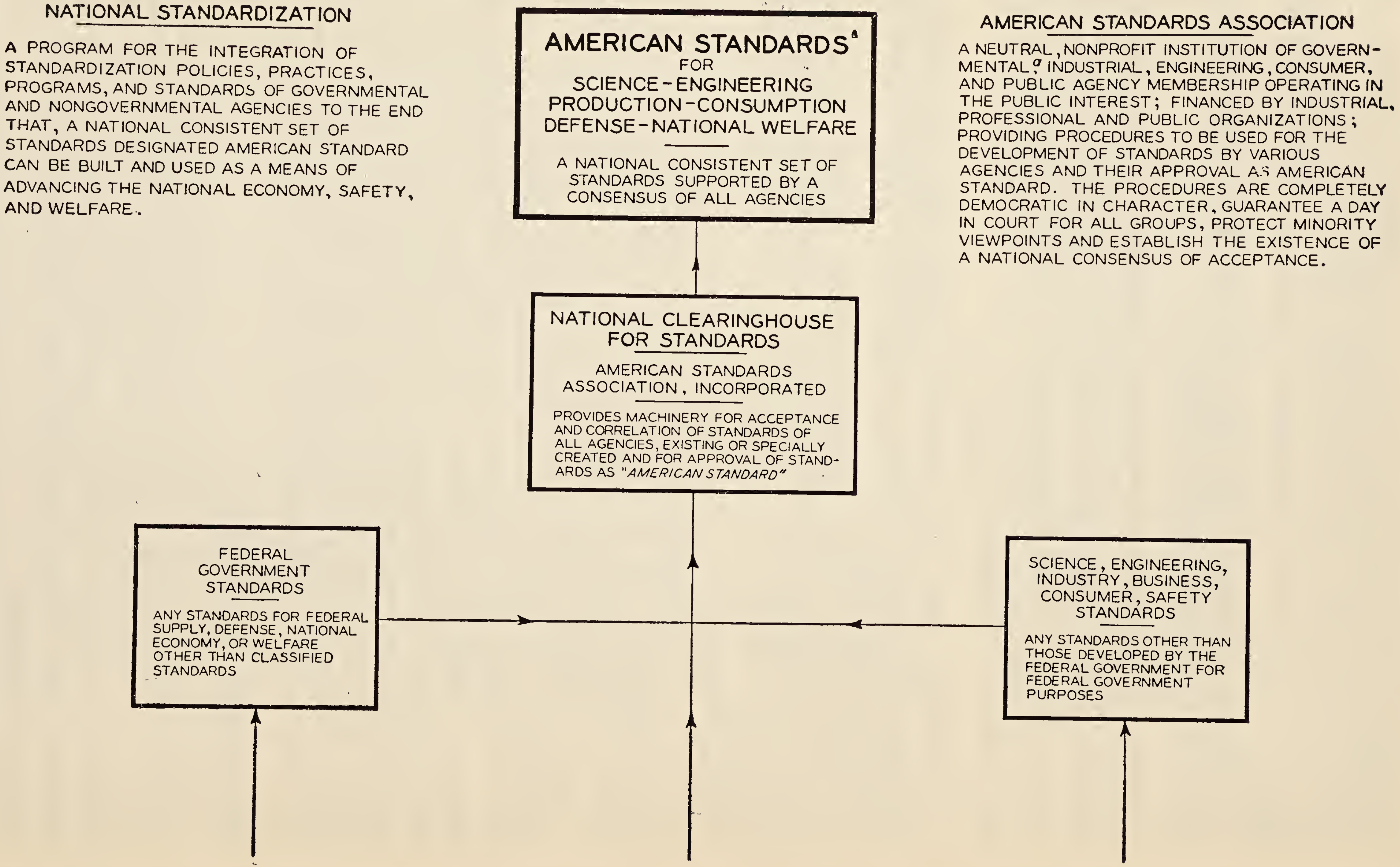
Certain American Standards have been adopted as ordinances and regulations by municipal, state, and federal governments and are, therefore, enforced by law. In the case of all other American Standards, the choice of whether or not they are adopted and used is left entirely to those for whose benefit they were developed. In general, however, an American Standard will be withdrawn if on review it is found to be in disuse. All American Standards are reviewed at regular intervals and are either reaffirmed, revised, or withdrawn. The relation of the American Standards to other standards in the United States is shown in Chart 3-1.

INTERNATIONAL COOPERATION

The ASA is not merely national in scope. It is the United States member of the International Organization for Standardization (ISO). Moreover, through the United States National Committee, an arm of the ASA, it holds membership in the International Electrotechnical Commission. The IEC, which is considerably older than ISO, serves as the Electrical Division of the latter.

This extension of the standards movement beyond our borders was an

Chart 3–1. National Standardization in the United States of America.



NATIONAL STANDARDIZATION

A PROGRAM FOR THE INTEGRATION OF STANDARDIZATION POLICIES, PRACTICES, PROGRAMS, AND STANDARDS OF GOVERNMENTAL AND NONGOVERNMENTAL AGENCIES TO THE END THAT, A NATIONAL CONSISTENT SET OF STANDARDS DESIGNATED AMERICAN STANDARD CAN BE BUILT AND USED AS A MEANS OF ADVANCING THE NATIONAL ECONOMY, SAFETY, AND WELFARE.

AMERICAN STANDARDS[a]
FOR
SCIENCE-ENGINEERING
PRODUCTION-CONSUMPTION
DEFENSE-NATIONAL WELFARE

A NATIONAL CONSISTENT SET OF STANDARDS SUPPORTED BY A CONSENSUS OF ALL AGENCIES

AMERICAN STANDARDS ASSOCIATION

A NEUTRAL, NONPROFIT INSTITUTION OF GOVERNMENTAL,[a] INDUSTRIAL, ENGINEERING, CONSUMER, AND PUBLIC AGENCY MEMBERSHIP OPERATING IN THE PUBLIC INTEREST; FINANCED BY INDUSTRIAL, PROFESSIONAL AND PUBLIC ORGANIZATIONS; PROVIDING PROCEDURES TO BE USED FOR THE DEVELOPMENT OF STANDARDS BY VARIOUS AGENCIES AND THEIR APPROVAL AS AMERICAN STANDARD. THE PROCEDURES ARE COMPLETELY DEMOCRATIC IN CHARACTER, GUARANTEE A DAY IN COURT FOR ALL GROUPS, PROTECT MINORITY VIEWPOINTS AND ESTABLISH THE EXISTENCE OF A NATIONAL CONSENSUS OF ACCEPTANCE.

NATIONAL CLEARINGHOUSE FOR STANDARDS

AMERICAN STANDARDS ASSOCIATION, INCORPORATED

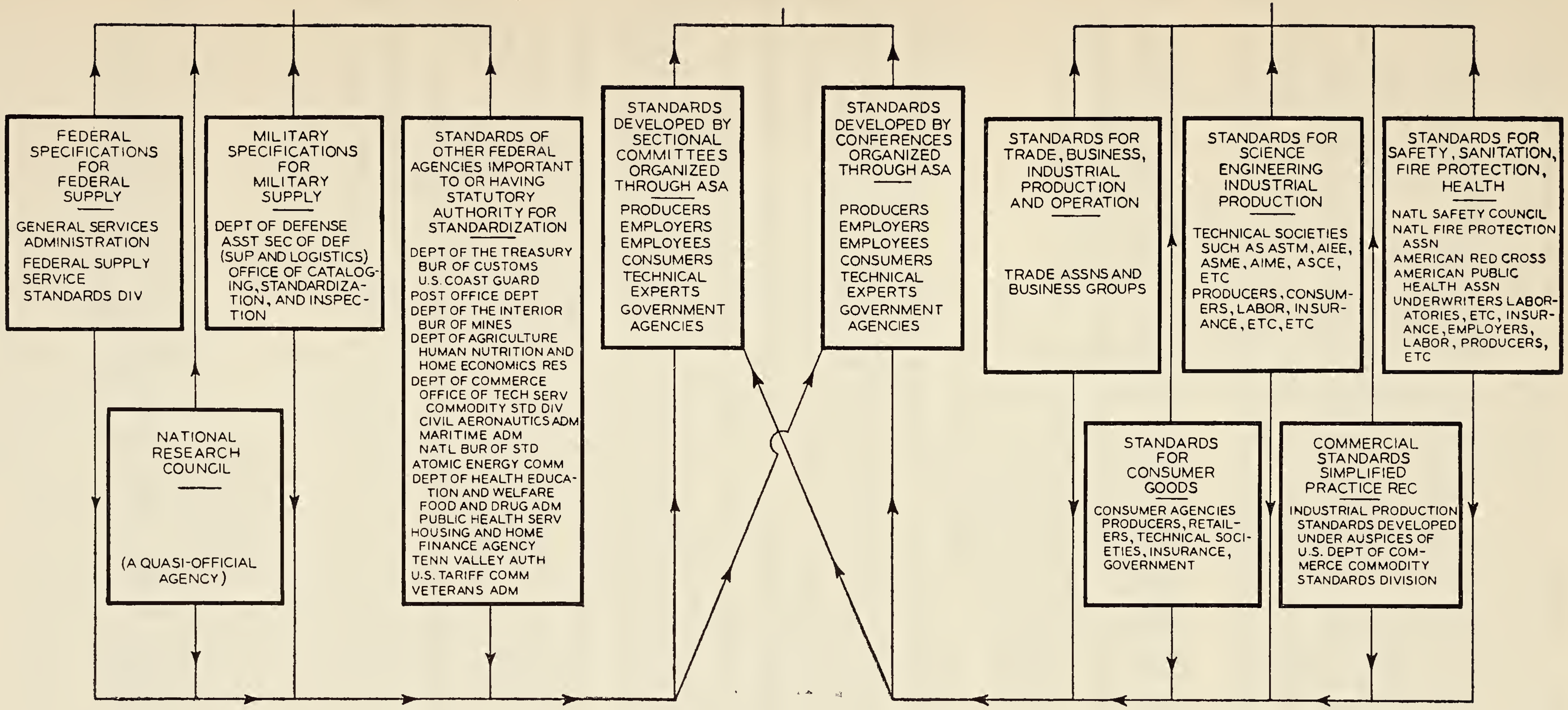
PROVIDES MACHINERY FOR ACCEPTANCE AND CORRELATION OF STANDARDS OF ALL AGENCIES, EXISTING OR SPECIALLY CREATED AND FOR APPROVAL OF STANDARDS AS "*AMERICAN STANDARD*"

FEDERAL GOVERNMENT STANDARDS

ANY STANDARDS FOR FEDERAL SUPPLY, DEFENSE, NATIONAL ECONOMY, OR WELFARE OTHER THAN CLASSIFIED STANDARDS

SCIENCE, ENGINEERING, INDUSTRY, BUSINESS, CONSUMER, SAFETY STANDARDS

ANY STANDARDS OTHER THAN THOSE DEVELOPED BY THE FEDERAL GOVERNMENT FOR FEDERAL GOVERNMENT PURPOSES


FEDERAL SPECIFICATIONS FOR FEDERAL SUPPLY
GENERAL SERVICES ADMINISTRATION
FEDERAL SUPPLY SERVICE STANDARDS DIV
MILITARY SPECIFICATIONS FOR MILITARY SUPPLY
DEPT OF DEFENSE ASST SEC OF DEF (SUP AND LOGISTICS) OFFICE OF CATALOGING, STANDARDIZATION, AND INSPECTION
NATIONAL RESEARCH COUNCIL
(A QUASI-OFFICIAL AGENCY)
STANDARDS OF OTHER FEDERAL AGENCIES IMPORTANT TO OR HAVING STATUTORY AUTHORITY FOR STANDARDIZATION
DEPT OF THE TREASURY
BUR OF CUSTOMS
U.S. COAST GUARD
POST OFFICE DEPT
DEPT OF THE INTERIOR
BUR OF MINES
DEPT OF AGRICULTURE
HUMAN NUTRITION AND HOME ECONOMICS RES
DEPT OF COMMERCE
OFFICE OF TECH SERV
COMMODITY STD DIV
CIVIL AERONAUTICS ADM
MARITIME ADM
NATL BUR OF STD
ATOMIC ENERGY COMM
DEPT OF HEALTH EDUCATION AND WELFARE
FOOD AND DRUG ADM
PUBLIC HEALTH SERV
HOUSING AND HOME FINANCE AGENCY
TENN VALLEY AUTH
U.S. TARIFF COMM
VETERANS ADM
STANDARDS DEVELOPED BY SECTIONAL COMMITTEES ORGANIZED THROUGH ASA
PRODUCERS
EMPLOYERS
EMPLOYEES
CONSUMERS
TECHNICAL EXPERTS
GOVERNMENT AGENCIES
STANDARDS DEVELOPED BY CONFERENCES ORGANIZED THROUGH ASA
PRODUCERS
EMPLOYERS
EMPLOYEES
CONSUMERS
TECHNICAL EXPERTS
GOVERNMENT AGENCIES
STANDARDS FOR TRADE, BUSINESS, INDUSTRIAL PRODUCTION AND OPERATION
TRADE ASSNS AND BUSINESS GROUPS
STANDARDS FOR SCIENCE ENGINEERING INDUSTRIAL PRODUCTION
TECHNICAL SOCIETIES SUCH AS ASTM, AIEE, ASME, AIME, ASCE, ETC
PRODUCERS, CONSUMERS, LABOR, INSURANCE, ETC, ETC
STANDARDS FOR SAFETY, SANITATION, FIRE PROTECTION, HEALTH
NATL SAFETY COUNCIL
NATL FIRE PROTECTION ASSN
AMERICAN RED CROSS
AMERICAN PUBLIC HEALTH ASSN
UNDERWRITERS LABORATORIES, ETC, INSURANCE, EMPLOYERS, LABOR, PRODUCERS, ETC
STANDARDS FOR CONSUMER GOODS
CONSUMER AGENCIES PRODUCERS, RETAILERS, TECHNICAL SOCIETIES, INSURANCE, GOVERNMENT
COMMERCIAL STANDARDS SIMPLIFIED PRACTICE REC
INDUSTRIAL PRODUCTION STANDARDS DEVELOPED UNDER AUSPICES OF U.S. DEPT OF COMMERCE COMMODITY STANDARDS DIVISION

NOTES: *ARROWS POINTING UPWARD INDICATE FLOW OF STANDARDS DEVELOPED BY GOVERNMENT OR NONGOVERNMENTAL AGENCIES THROUGH THE NATIONAL CLEARINGHOUSE FOR ACCEPTANCE BY ALL GROUPS CONCERNED AND FOR APPROVAL AS AMERICAN STANDARD.*

ARROWS POINTING DOWNWARD INDICATE FLOW OF POLICIES, PRACTICES, DATA, EXPERIENCES OF GOVERNMENTAL AND NONGOVERNMENTAL AGENCIES FOR CORRELATION THROUGH SECTIONAL COMMITTEES OR CONFERENCES ORGANIZED BY ASA FOR THE DEVELOPMENT OF STANDARDS BY ALL GROUPS SUBSTANTIALLY CONCERNED.

[a]AFTER 30 YEARS OF JOINT OPERATION OF ASA WITH INDUSTRY, TEN GOVERNMENT DEPARTMENTS AND AGENCIES WITHDREW FROM MEMBERSHIP IN 1948, AT THE TIME OF STATE INCORPORATION OF ASA. TECHNICAL COOPERATION CONTINUED. NO CHANGE IN ASA MEMBERSHIP STRUCTURE TOOK PLACE AND GOVERNMENT AGENCIES MAY AGAIN HAVE MEMBERSHIP WHENEVER THEIR POLICIES PERMIT.

ASA FINANCED BY INDUSTRY, BUSINESS, PROFESSIONAL AND PUBLIC INTEREST GROUPS BECAUSE NONGOVERNMENTAL GROUPS PROFIT FIRST AND MOST BY STANDARDIZATION WORK.

FEB. 15, 1956

inevitable and highly desirable development. Cordial international cooperation in the development and adoption of standards, as well as in every other activity, can do much to prevent fatal conflicts among nations.

National and international standards are basically the same, and their development is based on the same principles. However, the writing and adoption of an international standard is infinitely more difficult because it involves larger groups of people who have different national traditions, speak different languages, use different systems of weights and measures, and are usually even more reluctant than national groups to sacrifice some of their sovereignty.

In spite of these difficulties, the international standards movement is gaining ground and every step forward, however small, means further progress toward international cooperation and peace. As the official organization representing American interests at the standards council of nations, the ASA has rendered outstanding service.

The Future

Much has been achieved by the ASA, but much more remains to be done. The standardization movement is making constant progress; and the ASA is not limited in its scope. A vast need for standards exists in such new technologies as electronics, automation, development of plastics and synthetics, and utilization of nuclear energy. Many older technologies have hardly begun to make use of the services that the ASA can offer. In all branches of industry, technology, and science many overlapping and competing standards still exist. More generous cooperation among the various agencies involved should help eliminate duplication through the facilities of the ASA. Another great task, just begun, is bringing government specifications more in line with industry standards and practices.

As long as the ASA maintains the present excellence of its performance, it will be able to cope with all the demands that can be put upon it within the framework of its constitution. Fortunately the ASA's organization and rules of procedure assure the continuance of this excellent work and make it possible for the Association to adapt itself to any new task that may lie in store.

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4. CONTRIBUTIONS OF GOVERNMENT AND PRIVATE AGENCIES TO NATIONAL STANDARDS

E. C. CRITTENDEN

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The Role of the Government

SYSTEMATIC standardization as a conscious undertaking is a relatively modern development. In particular the rise of the national and international standardizing organizations which now cover the world has occurred within the last half-century. Nevertheless, actual standardization of practices is an essential element in community life. Standardization in the general sense has developed concurrently with government. In fact, next to providing for the common defense against external enemies, the chief reason for the existence of formal government is the need for the establishment and the enforcement of standards of practice.

The fact that governments are usually expected to enforce compliance with the standards which they establish might seem at first sight to give a basis for distinction between governmental standards on the one hand as mandatory, and nongovernmental ones on the other hand as voluntary. There are many standards which can be thus simply classified, but both historically and in modern industrial standardization the line of division between the two classes has not been so definite. The need for a standard having been recognized, the choice of a channel for developing and promulgating it may be merely a question of expediency. The impetus for governmental action is often given by private initiative, so that what appears on the record as a requirement of government is really the expression of voluntary agreement among those concerned with a specific problem. Government thus becomes merely a mechanism for implementing the judgment of whatever segment of the people may have sufficient interest to express its views. On the other hand some extremely important standards developed by private organizations have become so widely used that they have in effect become a part of the law of the land without explicit governmental adoption.

WEIGHTS AND MEASURES, TRADE AND INDUSTRIAL STANDARDS

Among standards affecting commerce and industry the establishment of standard weights and measures is one of the most obvious responsibilities of governments, but from early times requirements regarding quality of goods have received almost as much attention as the measurement of quantities. Settlers in the American colonies brought with them not only the weights and measures customarily used in England but also the idea of governmental control to assure fair dealing between producer, dealer, and consumer of products. It is perhaps significant that the Constitutional Convention of 1787 was unanimous in deciding to grant to Congress the power to regulate commerce among the states and with foreign countries, as well as to fix the standards of weights and measures.

However, the force of custom and common law among us, as distinguished from statutory enactments, is well illustrated by the fact that the Congress has never exercised its power to fix the standards of weights and measures in a basic or comprehensive way. The weights and measures which we use in everyday life are practically those developed by common usage, and there is no federal law defining them. As a result of congressional inquiries about standards used in the collection of import duties at various ports, sets of standards were prepared early in the nineteenth century by the Department of the Treasury for use at the principal custom houses. In 1836 the Congress directed the Secretary of the Treasury to deliver to each state a complete set of these standards "for the use of the States, respectively, to the end that a uniform standard of weights and measures may be established throughout the United States." The states have used the standards thus provided, and most of them have formally adopted them by legislative action. As a consequence there is uniformity in the basic units of commercial weights and measures throughout the country without any specific requirement enacted by the Congress.

A few acts of Congress have established specific standards affecting trade. Under the authority to fix standards of weights and measures, the capacities of barrels for dry commodities were prescribed in 1915 and those of hampers and some types of baskets for fruits and vegetables in 1928, the sizes established being mandatory in intrastate as well as interstate commerce. On the other hand, laws enacted in 1916 establishing standard barrels for lime, defined by weight of contents, and sizes of certain types of baskets for small fruits, berries, and vegetables, were made to apply only in interstate commerce.

Federal legislation on items which might be considered as industrial standards has been largely directed to meet special needs in government operations rather than being primarily intended to control industrial practice. For example, although the Standard Gauge for Sheet and Plate Iron and Steel was designated by Act of Congress in 1893 as "the only standard gauge" for these materials in the United States, its use was made mandatory only in determining duties and taxes levied by the United States.

GOVERNMENT REGULATORY AGENCIES

While there has thus been little mandatory standardization by direct legislation, federal control in some important fields has been delegated to regulatory agencies which issue standards of many kinds. The Interstate Commerce Commission makes regulations affecting equipment and operating procedures in transportation by land and water; standards for air transportation are established by the Civil Aeronautics Board, those applying to communications by the Federal Communications Commission. The Food and Drug Administration promulgates standards which set minimums of quality permissible for food and drugs. The Department of Agriculture has established standards for grading of a great many of the more important agricultural commodities produced in this country. Some of these standards are mandatory for futures trading in certain staple products, such as cotton, grain, potatoes, butter, and wool tops. Others are applied in specific markets or on request of producers of other products, including meats, poultry, eggs, butter, tobacco, and fresh or processed fruits and vegetables. An interesting exception to the general rule of federal control in agriculture is fertilizer; the marketing of this commodity is controlled by state laws in which a high degree of uniformity has been attained by cooperation between manufacturers and state officials through the Association of Official Agricultural Chemists.

Private and Governmental Standards Work

The activities mentioned above illustrate government influence or control in diverse fields where standardization of practice has been essential in meeting specific needs although not planned as a part of any comprehensive program of standardization. It is necessary to recognize that in government as in industry we have a complex structure. The picture of The Government as an organic unit acting with a clearly established program is especially misleading in the field of standardization. In the federal government alone there are dozens of departments and agencies each having a more or less definite scope of responsibility and authority. In order to carry on their assigned operations many of these agencies must establish or formally recognize standards of practice of various kinds. A general policy prescribed by law is that a government agency which sets up standards controlling the operations of others must hold hearings which give an opportunity for those concerned to express their views, but there is no central control of the standards which may be established. A parallel situation exists in industry where we have literally hundreds of technical and commercial organizations which promulgate standards to serve their own needs and purposes. In most cases these standards have been developed within the organization. This is still true in spite of the progress which has been made in the development of systematic, coordinated national standardization, including provision for representation of all parties materially concerned with the requirements of a standard.

This complex situation puzzles observers from other countries where standardization seems to be more simply organized and directed, although really far less advanced than ours. We have a maze of standards with perhaps too little coordination between them. The organizations which carry on the work sometimes seem more concerned with maintaining their own prestige than with obtaining agreement upon generally acceptable standards. There is much emphasis placed in some circles upon the necessity of keeping industrial standardization free from governmental control, while some other groups are convinced that the only practical way to get acceptable standards established, especially for goods of interest to the individual consumer, is to have them developed by a governmental agency. Within the government some agencies give active support to the development of national industrial standards, while others look with suspicion upon such standards as being possible tools for restraint of trade. This diversity of opinion and the absence of comprehensive planning are characteristic of our American way of doing things; in spite of the apparent conflict of interests, standardization proceeds because there is an underlying spirit of cooperation and a general desire to obtain a reasonable degree of order in our industrial and commercial operations without sacrificing the freedom of action necessary for progress.

Mr. Justice Frankfurter is quoted as saying that "government as a rule undertakes no service or regulation except after private agencies have proved themselves incapable or unwilling." Certainly the prospect or the threat that government agencies would enter into the field of industrial standardization has stimulated private agencies to accelerate their own work. Conversely, as our technical societies and commercial associations have given more nearly adequate support for the development of standards and for their coordination on a national scale, the grounds for proposing governmental action have been largely removed.

In the development of commodity standards, or specifications for goods and materials, the government as the largest single purchaser of industrial products has had great influence. Complaints that government specifications have differed from those accepted by other purchasers may have often been justified, but for many commodities the differences arose because the customary specifications were not adequate for the conditions under which government purchases must be made and incidentally did not protect the interests of the general public as purchasers. On the other hand for some commodities specifications adequate for general use have for many years been established and kept abreast of current developments by close collaboration between representatives of government, manufacturers, and other users of the materials. In such activities governmental and private industrial groups have been so closely interrelated that it would be futile to attempt to assess the relative value of the contributions made by each. A few examples may be given to illustrate the connections which exist between governmental and private work on standards, without encroaching too much upon the scope of other sections in this volume describing work in specific fields or by particular organizations.

An early example of joint establishment of specifications is the case of electric lamps; the first "standard specifications" for lamps were issued in 1907, and that activity under various auspices has continued to the present time. Similar coordination of government and general commercial standards has promoted improvement and the maintenance of high quality in portland cement, electric dry cells, and many other commodities for which the government is an important purchaser. In the establishment of standard forms and dimensions of screw threads the governmental National Screw Thread Commission, its successor Interdepartmental Screw Thread Committee, and committees sponsored by the engineering societies have attained notable success in keeping government and industry standards in unison.

Finally it should be emphasized that in the work of many private or nongovernmental organizations developing standards government agencies have played an important part, particularly in supplying pertinent information resulting from research and testing done in government laboratories. The contribution of the National Bureau of Standards in this way through hundreds of memberships in technical committees is too well known to need detailed description. A similar service, less widely known, has been given by the Forest Products Laboratory of the Department of Agriculture in relation to all varieties of wood products.

The Government and the American Standards Association

In the development of the American Standards Association as the coordinating body in the national standards movement governmental agencies had an important part. The enlargement of membership and the broadening of scope of the ASA's parent organization, the American Engineering Standards Committee (AESC), were largely a result of the interest taken by representatives of government departments. The work done by the Navy, with the technical assistance of the National Bureau of Standards, in preparing safety codes for industrial operations during the first World War led to proposals for the establishment of a series of such codes on a national basis. Two conferences held at the Bureau of Standards in 1919 to consider this proposal were attended by more than a hundred delegates, representing not only federal, state, and city governments, but also engineering societies and associations of public utility companies, insurance companies, manufacturers, and labor groups. These conferences recommended that a national program be undertaken following the general methods of operation planned by the AESC, with the understanding that other engineering, commercial, and governmental organizations interested in engineering or industrial standards would be admitted to membership in that committee. That step was taken immediately, and in 1920 two additional government departments, Agriculture and Interior, joined the organization along with the Society of Automotive Engineers and thirteen national associations representing insurance and safety groups and the electrical and gas industries. Government departments took a full part in all activities of the ASA until its incorporation in 1948 created legal difficulties with regard to participation in the general management of the Association; since that time, however, participation has continued in the technical projects of the Association.

Standardization can be made effective only by dictatorship or by common agreement and cooperation. In American industry dictatorship is inconceivable. Actual control of industrial operations or products by those men who happen to be entrusted for the moment with the powers of government would certainly be tolerated only in extreme emergency. We undoubtedly need better coordination than has yet been attained in the processes by which standards of national importance are established, but that is an end to be attained by cooperation of all concerned and not by edict of any authority. So in the future we must expect to see private technical, industrial, and commercial organizations take the lead in national standardization as they have done in the past, with such collaboration from government as may be found practicable. The policy of federal goverment agencies as indicated by recent announcements is certain to make that collaboration even more complete than in the past.

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5. THE INTERNATIONAL STANDARDS MOVEMENT

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NATIONAL STANDARDS AND THE BEGINNING OF THE INTERNATIONAL STANDARDIZATION MOVEMENT

Since the beginning of the twentieth century the benefits to be derived from standardization have been increasingly apparent to progressive corporations in the United States. Individual company standards were early developed and were followed by industry-wide standards established through technical societies and trade associations. But recognition of the need for standardizing on a national basis came more slowly.

While the British Engineering Standards Association was in smooth operation prior to the first World War, until then it was the only national standards agency in existence. World War I gave the impetus to national standardization in all countries involved in that struggle and at the same time established the need of an international standards movement.

International standardization was undertaken in several specialized fields many years before the importance of such a world-wide movement became apparent to national standardizing bodies. Undoubtedly, however, the work of such pioneering groups as the International Electrotechnical Commission, the International Commission on Illumination, and others blazed the trail for the broader movement which was undertaken in 1926.

With the growth of international trade and the increasing interest in foreign industrial development that followed World War I, it became evident that cooperation among the existing national standardizing bodies to unify the most effective standards could result in untold benefit to industry, commerce, and science throughout the world.

To accomplish such international cooperation it was necessary to overcome serious difficulties, of which national temperament, language, historical and industrial background, long-established rivalries, and prejudice against new ideas were but a few.

INTERNATIONAL FEDERATION OF THE NATIONAL STANDARDIZING ASSOCIATIONS (ISA)

In April 1921 a Conference of Secretaries of the National Standardizing bodies was held in London under the auspices of the British Engineering Standards Association, attended by representatives of Belgium, Canada, Great Britain, Holland, Norway, Switzerland, and the United States.

The arrangement for the systematic interchange of information among these seven national standardizing institutions which resulted from this conference (although unofficial and informal in character) was a most important step forward in the development of an international organization.

This intimate sharing of information quickly proved the great benefits that could result from organized cooperation in the field of international standards, and crystallized in the creation of the International Federation of the National Standardizing Associations (ISA) in 1926.

Among the pioneers in this movement was Dr. Paul G. Agnew who led the American Standards Association in its work with all three of the international organizations—ISA, the United Nations Standards Coordinating Committee (UNSCC), and the International Organization for Standardization (ISO), which succeeded ISA during and after the second World War.

Others who crusaded for international standards and who, with Agnew, were largely responsible for the establishment of ISA were: C. LeMaistre of Great Britain, R. J. Durley of Canada, E. Hijmans of Holland, A. Eriksen of Norway, M. Zollinger of Switzerland, and Gustave L. Gerard of Belgium.

In 1926, fourteen countries had national standardizing bodies in successful operation: Austria, Belgium, Canada, Czechoslovakia, France, Germany, Great Britain, Holland, Italy, Japan, Norway, Sweden, Switzerland, and the United States. All became members of ISA.

Between the first and second world wars, the ISA organized approximately fifty international projects. Among its most important accomplishments were the following:

The international reference temperature for limit gauges was established at 20° C or 68° F.

The inch-millimeter conversion ratio, 25.4, became a world standard.

Preferred numbers, an effective tool in the hands of the designer and the standardizer, also became an international standard.

An international system of limits and fits for cylindrical parts and an international system for paper sizes were developed by ISA committees and were generally adopted on the European continent.

Standardization of the sound-track location on 16-mm. sound film (which established world-wide interchangeability between equipment for taking and projecting this film) became an international standard. This was of particular interest to American industry.

The ISA functioned with expanding usefulness until 1939, when World War II made its continued operation impossible.

UNITED NATIONS STANDARDS COORDINATING COMMITTEE (UNSCC)

To hold together during the war the threads of the international fabric which was in the process of being successfully woven, an interim organization was set up in 1943 under the name of the United Nations Standards Coordinating Committee (UNSCC).

The stated purpose of this Committee was to expedite cooperation among the allied belligerent countries in standardization matters as an aid to the joint production and effective use of war supplies and equipment, as well as to assist in the work of rehabilitation. Offices were established in London and New York.

The wisdom of setting up this interim committee was soon made evident. Almost immediately it was called upon to undertake such important projects as:

> Work on building materials and equipment, requested by the Industrial Rehabilitation Division of the United Nations Relief and Rehabilitation Administration.
>
> Standardization of flat-bottom rails needed to rebuild the heavily damaged transportation systems of France and the other occupied countries, suggested by the Inter-Allied Transportation Committee.
>
> A project for the suppression of radio interference by the British Standards Institution.

These were followed by others of great significance.

The countries which constituted the membership of the United Nations Standards Coordinating Committee were:

Australia
Brazil
Belgium
Canada
Chile
China
Czechoslovakia
Denmark
France
Great Britain
Mexico
Netherlands
New Zealand
Norway
Poland
South Africa
United States
USSR

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

With the ending of World War II, a first step in the creation of a new and permanent international standardizing body was taken by UNSCC at a meeting held in New York in October 1945. This initial meeting led to a series of conferences held in Paris and London in 1946, by members of the Council of UNSCC and representatives of the International Federation of the National Standardizing Associations, which was still in existence though its activities had ceased during the war.

Foremost among the policies set up at these conferences and the organizational meeting of October 1946 in London was that the new association should be in the form of a merger of the original Federation (ISA) and the UNSCC, and that the technical work of both organizations should be consolidated and continued. The name finally agreed upon was the International Organization for Standardization, and its symbol—ISO. Again, Dr. Paul G. Agnew was a guiding figure in setting up policies and procedures for ISO. He was ably assisted by Dr. Eugene C. Crittenden, then Associate Director of the National Bureau of Standards.

The first meeting of this newly formed association was held in Zurich in June 1947. At the time of the opening of the meeting twenty-four countries had ratified the constitution and rules of procedure of ISO. Therefore, these had gone into effect. Two additional countries were admitted during the meeting, making the total membership of ISO twenty-six countries. Today thirty-seven states make up its membership:

Australia
Austria
Belgium
Brazil
Bulgaria
Canada
Chile
Czechoslovakia
Denmark
Finland
France
Germany
Greece
Hungary
India
Indonesia
Ireland
Israel
Italy
Japan
Mexico
Netherlands
New Zealand
Norway
Pakistan
Poland
Portugal
Rumania
Spain
Sweden
Switzerland
Turkey
Union of South Africa
USSR
United Kingdom
USA
Yugoslavia

One of the outstanding achievements of the Zurich Conference was an arrangement whereby the International Electrotechnical Commission (IEC) affiliated with ISO and became the organization's Electrical Division, at the same time maintaining its autonomy.

The organizational structure set up for ISO is simple, as are the methods it employs to carry on its work. It consists of a General Assembly, made up of delegates from all its member bodies, which meets once every three years. From the entire membership representatives of 11 different countries are chosen to act as a Council. This Council meets at least once a year and is, in effect, the ISO Board of Directors. Council members serve for a term of three years. The General Assembly elects the President. The

Council elects the Vice-President and Treasurer, whose duties are limited and carefully defined. Permanent headquarters are in Geneva with a General Secretary as Chief Administrative Officer, supported by an adequate staff.

The ISO holds consultative status as a nongovernmental organization with the Economic and Social Council of the United Nations.

Methods

The method followed by ISO in developing unified standards is to set up technical committees in the fields selected by a majority of the Council. All members are invited to participate, but the project is carried on only when five or more countries agree to take an active part in it. One of the participants assumes the responsibility of the secretariat of the project. It is the obligation of each technical committee to develop a scope or "terms of reference" for its project, which must be approved by a majority of the Council before work is actually undertaken. When the work of each technical committee is completed the result is designated a "Draft ISO Recommendation," subject to acceptance by a majority of the members and final approval by the Council.

Work Achieved or in Progress

Technical committees of ISO have already developed 102 draft recommendations, of which 18 have become ISO "Approved Recommendations." Many more are in the process of formulation. Those approved cover such important standards as:

Reference temperature for industrial length measurements.
Method of determining photographic speed and exposure index.
Layout of periodicals.
Code for the abbreviation of titles of periodicals.
Aircraft connections for ground air conditioning.
Aircraft pressure cabin ground test connection.
Identification of aircraft pipe lines.
Designation of the direction of twist in textile yarns.
Preferred number series.
Diffuse transmission density.
Pipe threads for gas list tubes and screwed fittings.
System for transliteration of Cyrillic characters.

As is the case with standards established under American Standards Association procedure, the use of approved ISO recommendations remains entirely voluntary even for the members who participated in their development.

It must be apparent that the close cooperation of representatives of the far-flung nations making up the membership of ISO, working together in an effort to unify their standards, must prove a potent force in creating a better understanding among the nations of the world. As each country profits from the experience of the others, a steady improvement in the standard of living for the peoples of all nations must result.

OTHER INTERNATIONAL STANDARDS GROUPS

The first international industrial standardizing body was the International Electrotechnical Commission, formed in 1904 as a result of a resolution passed by the Chamber of Government Delegates at the St. Louis International Electrical Congress. The resolution urged that steps should be taken to secure the cooperation of the technical societies of the world by the appointment of a representative commission to consider the question of standardization of nomenclature and ratings of electrical apparatus and machinery.

The IEC, despite the interference of two world wars, has continued its important work in the field of electrical standards. In September 1954 the IEC celebrated its Golden Jubilee in Philadelphia. The importance of this meeting and the interest in the organization were evidenced by large delegations from member countries. Of the thousand persons who took part on this historic occasion, about half came from other lands. Out of 250 technical sessions, 43 International Electrotechnical Commission Recommendations were brought into final stages of approval. This was a greater number of world standards than the IEC had developed in all its fifty years.

Another of the early international standardizing groups is the International Bureau of Weights and Measures, created in 1875 by the Metric Convention. The United States is a signatory country.

Other international groups include:

The Universal Postal Union, which establishes standard rates for mail (governmental).
International Commission on Illumination.
International Civil Aviation Organization (a branch of the United Nations).
International Wool Textile Organization.
International Labor Organization (a branch of the United Nations).
International Federation for Documentation, which develops standardization work in the library field.
International Dairy Federation.

Many other organizations have done important standardizing work on an international scale.

AMERICAN-BRITISH-CANADIAN (ABC) MEETINGS

During the first half of 1942 it became apparent that serious delays and largely increased costs in the interchange of airplane, tank, and ship components would occur unless definite agreement could be reached on standard dimensions and on quality and test standards among the three allied nations—the United States, Great Britain, and Canada. The major handicap at that time was the difference in the fundamental design of screw threads between British and American practice.

In this emergency, Arthur M. Houser, a consultant to the Conservation Division of the War Production Board, and Archibald E. Smith, a civilian engineer in the War Department, developed a successful formula for solving this difficult problem. Houser had had long experience in screw thread design as Chief Engineer of Crane Company and as a member of the Interdepartmental Screw Thread Committee. Smith had long specialized in the design of screw threads for the War Department. The solution the two men reached seems a simple one in retrospect. It consisted of the establishment of a uniform thread angle and the rounding of the crests and the roots of the threads, which made a minimum demand on changes in threading tools and practice, though the adjustment was more difficult for the British than the Americans.

There were also serious differences among these English-speaking allies in regard to gauging practices as well as standards for limits and fits between mating parts. Other divergent features such as acme threads, buttress threads, and cylindrical fits needed unification to speed the war effort.

It appeared probable that solutions to these important problems could be found if the civilian and military experts of the three countries could be brought together in a series of conferences. The first American-British-Canadian (ABC) meetings were held in New York in December 1943. The progress made at these meetings lent encouragement to further work. Therefore, with the approval of William L. Batt, Vice Chairman of the War Production Board and Vice Chairman of the Combined Production and Resources Board, a commission was dispatched to London in August 1944, made up of eight leading engineering specialists—two from American industry, two from the U.S. military, one from the American Standards Association, one from the National Bureau of Standards, and two from Canada.

These London deliberations created a basis of understanding which did much to overcome the difficulties of wartime production and to simplify and expedite exchanges of components and assemblies. They also paved the way for later conferences in Ottawa in 1945, culminating in a formal agreement on Unification of Screw Threads, signed in Washington in November 1948.

After 1948 permanent Committees of the ABC countries were set up to continue this work. Among other accomplishments was an agreement on the Unification of Bolts and Nuts proportions.

An important ABC Conference was held in New York in June 1952 attended by 133 delegates. Out of this conference came plans for the extension of this work through joint committee deliberations. One of the most hopeful of these projects is being undertaken by a committee on the Unification of Drawings and Drafting Room Practice.

U. S. PARTICIPATION IN INTERNATIONAL STANDARDIZATION

While industrial and commercial executives in the United States took an early interest in standards, that interest was largely centered in company standards or individual industry-wide standards. The whole-hearted participation of the top management in the national standards movement was long delayed; this delay, in turn, influenced in a large degree their attitude toward international standardization. This attitude was due in part to the reluctance of many companies to interrupt their repetitive output and, in part, to a desire to establish their own specifications and designs. By many this was attributed to a feeling of self-sufficiency.

The lack of appreciation of the value of international standards, however, gradually disappeared as the growing need of a world market became apparent. Obviously our industrialists could not expect to sell goods manufactured strictly in accordance with American practice to foreign customers who had established specifications differing from ours. Therefore, some basis of interchangeability had to be established, which necessitated the adoption of unified standards.

To illustrate our change in attitude, in 1948 after the ISO had set up sixty-nine individual projects, the United States took an active part in only nine. Of these the Americans assumed the secretariat of seven. At the same time, France participated in twenty-seven projects and held twelve secretariats.

Now ISO has eighty-one projects and the United States has participating membership in thirty-six, holds the secretariat of eight, and has observer status in the rest.

THE FUTURE OF INTERNATIONAL STANDARDS

The future holds promise of a steady growth in influence and activity for the International Organization for Standardization. World markets have became vital to every industrial nation and to none more than the United States. Ideologies may capture the imagination and, therefore, momentarily the support of great masses of people. But that form of support is at best ephemeral. A longing for peace may cause nations to make great sacrifices, but a time will come when such sacrifices will be no longer bearable or possible.

The exchange of goods and services among nations of the world, however, established on a foundation of mutual aid and profit is sound in theory and practical in operation. It can be perpetuated indefinitely. Ultimately such profitable exchange might become the key to the door to peace.

In promoting the development of world-wide markets, there is no formula more effective than one which will assure to manufacturers economy in production, and to wholesale and retail distributors merchandise that can be sold competitively and can be used universally. For providing this formula, international standardization has no substitute. It stands apart and alone.

The International Organization for Standardization has demonstrated its complete competence. It has the organization, the plans, and the policies to carry forward its program effectively. It deserves and will, it seems certain, have the support of forward-looking executives throughout the industrialized nations of the world.

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PART II

Liberating Initiative and Productive Forces by Applying Standards

6. SIGNIFICANCE OF THE NATIONAL BUREAU OF STANDARDS FOR INDUSTRIAL PROGRESS

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INTRODUCTION

STANDARDS for physical measurements are perhaps the oldest and most basic of all types of standards. They are fundamental to commerce, to industrial technology and to science.

The exchange of commodities in commerce involves agreement as to the amount of each commodity to be exchanged. When the determination of amount involves measurement other than simple counting, the process of agreement implies mutually satisfactory measurement standards. And even with counting some sort of standard must exist for the things to be counted. Thus, without standards to define measures of weight, extent, quality, or value, modern commerce could not exist.

It has long been recognized that the establishment of such standards is a logical function of government because standards of measurement must have authority and prestige if they are to be generally acceptable as a means of determining value in commercial activity. It is significant that the fifth listed power given to the Congress by the Constitution, namely "To coin Money, regulate the Value thereof, and of foreign Coin, and fix the Standard of Weights and Measures," links the two important measures of value that are involved in the exchange of nearly all goods.

Throughout most of history and well into the era opened by the Industrial Revolution, measurement standards were limited essentially to weight and length and the directly derived standards, area and volume. But as new products and techniques were introduced into commerce by modern technology, many new and relatively complex standards for measurement had to be devised. Electrical and electronic products provide excellent examples. Furthermore, as production techniques became more efficient, largely as a result of increased engineering competence to measure and control dimensions and other physical characteristics with greater precision, it became necessary that reference measurement standards be known and usable with greater accuracy. These characteristics define the basic nature of a dynamic measurement standards program: there must be extension of standards to the newly explored areas of science and technology and there must be a continual refining of the accuracy in older areas.

The importance of adequate standards for physical measurement to industrial progress ties directly to the dependence of technological growth on scientific research and development and to the dependence of both on measurement. Progress in our knowledge of the properties of materials and natural phenomena, and in our ability to apply this knowledge to the material benefit of mankind, depends on our ability to measure these properties and express the results in numbers. In order for the numbers to have general value, there must be units and reference standards to give them meaning.

Modern manufacturing differs from individual craftsmanship primarily through differences in measurement techniques. In manufacturing, parts are built in conformance with dimensions or other physical characteristics as defined in a blueprint or specification. Measuring instruments calibrated in terms of reference standards are necessary to assure compliance with the specified requirements. An individual craftsman may construct his product by fitting, tailoring, or adjusting to a mating part or object or to the particular desires of his customer. Standards are not necessary and frequently no measuring instruments are needed since characteristics can be determined by fitting rather than by measuring.

A lone manufacturer can operate with a set of standards satisfactory only to him. But if he buys components from others, or distributes his products in competition with others, or to be used in conjunction with other products, or as guaranteed to meet certain performance requirements, then widely acceptable standards are necessary. It is easy to imagine the confusion that would exist in the electrical industry, for example, if there were no general agreement as to the true magniture of a volt or an ohm. Similarly in science, a lone worker can accumulate data which would have meaning to him by using his own measurement standards. But if he is to exchange information with other scientists—a most essential activity for progress—or if his discoveries are to be useful to engineers and technologists, then there must be generally acceptable standards to give general meaning to his measurements.

The provision of these standards for physical measurement, which are so essential to the orderly progress of science, technology, and commerce, is a responsibility entrusted by the Congress to the National Bureau of Standards.

Origin and Growth of the Bureau

The progress of science and technology toward the end of the nineteenth century had led to the development of a wide variety of measuring instruments involving many quantities other than length and weight. There developed an acute need for a national laboratory where such instruments could be calibrated in terms of recognized standards. This need prompted the nation's scientists and engineers, led by the National Academy of Sciences, to urge the Congress to establish a national standardizing laboratory. Accordingly, in 1901, the Congress authorized a National Bureau of Standards to develop and maintain the standards for physical measurement together with the development of calibration techniques for their effective utilization. The new Bureau was also authorized to determine fundamental physical constants and properties of materials in accordance with the needs of scientific and manufacturing interests.

The Treasury Department's Office of Weights and Measures, which had had responsibility for the length and mass standards for more than sixty years, was also transferred to the new Bureau.

The most important initial task confronting the new Bureau was the provision of standards and calibration services for electric measurements, temperature measurements, and precise subdivisions of the length and mass standards. With these and nearly all other standards, there has been a continuing need to extend and refine them. For example, the first electric standards had satisfactory accuracy only for a very short time, and from the beginning an objective was to obtain standards in terms of what is called absolute measure. This meant relating the electric standards directly to their fundamental definitions in terms of length, mass, and time. This goal was not achieved on an international basis until 1948.

The first electrical standards were for direct current application. It was next necessary to derive suitable alternating current standards, first for the low frequencies used in electrical power systems, next for the audio frequencies used in telephone communications, and later for the radio frequencies. Radio has expanded through the opening of new bands at high frequencies and generally as the frequency has increased, new and more difficult standardization problems have arisen.

Similarly with temperature standards, a provisional accuracy was achieved over a limited range of temperatures. This was followed by efforts to increase the accuracy with which temperatures could be determined, together with the devising of techniques to extend the standards to ever higher and lower temperatures in accordance with the expanding needs of scientists and engineers.

About 1904, at the urging of the American Chemical Society, work was started on standards of a somewhat different type, namely, standards of purity for chemical reagents. A little later, at the request of iron and steel technologists, a standards sample program was started. Such samples are materials of precisely determined chemical or physical properties. They are used extensively to control accuracy and quality in manufacturing operations.

The rapidly growing competence of the Bureau in the field of physical measurement soon led to requests for its services in evaluating performance characteristics of various materials. The Bureau's fourth annual report told of tests which had been made on the tensile strength of the elevator cable at the Washington Monument and of tests on cement which had been used in the construction of the new House of Representatives Office Building. This was the beginning of the Bureau's program of assisting other government agencies in the evaluation of materials for its use and in the development of standard specifications for the purchase of materials.

About this time there were many requests from industry for assistance in the development of standard testing techniques and soon there was an extensive program on methods of testing a wide variety of materials, mechanisms, and structures.

America's entry into World War I resulted in a major reorientation of the Bureau's program. A large percentage of the staff became involved in technical developments of specific interest to the military, and many scientists and engineers who were commissioned as officers were assigned to work at the Bureau. A few of the specific achievements included: a mechanical method of fabricating precision gauge blocks which supplied a critical tool needed in large quantities by the mass production industry and which previously had been available only in limited quantities; the development of high quality glass for use in military optical instruments and producing large quantities of it (previously the country had depended completely on Germany for its supply of this critical material); and the development of sound ranging devices for the Signal Corps.

Many of the developments started during the war, such as the optical glass program, continued after the war and, to an increasing extent, other government agencies looked to the Bureau for assistance in adapting technological developments to meet their own operating needs. Outstanding developments for the civilian agencies of government included: a radio blind-landing system, the forerunner of the present widely used ILS system, and the radio sonde, now used daily throughout the nation and in many parts of the world to collect data on weather conditions in the upper atmosphere.

Again in World War II, the Bureau directed its major effort to military problems. Three important achievements were: the development of proximity fuses for bombs and rockets; the development of the first automatic homing-guided missile, the Bat; and many key contributions to the atomic bomb project, beginning with the appointment, by the President, of the Bureau's Director in 1939 as the chairman of a committee to investigate the possibilities of using atomic energy for military purposes.

The increasing importance of technology to so many aspects of our national welfare has led to a continuing high level of support to the Bureau's program by other government agencies. At the present time about 70 per cent of the Bureau's funds come as transfers from other government agencies for specific services to them.

The Bureau's concern with standards of practice, such as screw thread standards, began about 1904 with an attempt to resolve difficulties due to the lack of interchangeability of fire hose couplings. In 1918 screw thread problems were of sufficient industrial and military importance that the Congress established the National Screw Thread Commission. The Bureau played a prominent part in the work of the Commission and in that of its successor, the Interdepartmental Screw Thread Committee. The latter represented U. S. Government interests in cooperating with the American Standards Association and with British and Canadian representatives in reaching the 1948 accord on unified standards for certain types of screw threads. It has been estimated that the lack of fit between threaded parts of British and American military equipment cost many tens of millions of dollars in World War II.

Another standardizing activity relates to safety codes. Because of the Bureau's experience in electrical measurements, the Congress made special provision shortly before World War I for an investigation of the safety characteristics involved in the distribution of electrical energy at high voltages. This led to recommended rules of practice which later became part of the National Electrical Safety Code. Parts of this Code have become American Standards and the Bureau now serves as sponsor of the American Standards Association project in this area.

Following World War I the Bureau developed major programs in other areas of standards of practice such as commodity standards and simplified practices procedures. These programs continued to grow during the 1920's and resulted in many significant contributions to the American industrial economy. In 1925, for example, the Bureau's Director estimated, on the basis of information obtained from industries that had adopted simplified practice recommendations, that annual savings of about $300 million had been achieved. This was 150 times the Bureau's annual budget at that time.

With the growth in scope and effectiveness of the work of the American Standards Association there was less need for direct responsibility by the Bureau for such standards, and this activity gradually declined in size and relative importance. In 1945, the Secretary of Commerce asked the Bureau's Visiting Committee to study and make recommendations concerning a policy toward standards. A special committee was established for this purpose under the chairmanship of Charles E. Wilson of the General Electric Company. The membership included a widely representative cross-section of American commerce, industry, and science. Some of the committee's recommendations were:

1. That efforts in standardization be coordinated and promoted through a disinterested private agency organized to function in the broad public interest, and that this function can most logically be fulfilled by the American Standards Association.
2. That the true functions of the National Bureau of Standards in connection with standardization should be those of basic research, furnishing of facts, measurements, and technical assistance in the development of adequate testing methods, with assistance to all responsible groups engaged in standards development.
3. That the remaining commodity standards work in the Bureau, consolidated in a Commodity Standards Division, be transferred from the Bureau to more suitable status elsewhere in the Department of Commerce where association with groups engaged in market analysis and research would place the program under auspices to provide more effective assistance to standardizing groups.

The latter recommendation was implemented in 1951, and now the National Bureau of Standards has no direct responsibility in the formulation of standards of practice. It does, however, cooperate extensively with private standardizing groups in the development of such standards, particularly in furnishing technical data on properties of materials or on testing methods.

The enforcement of compliance with weights and measures standards in commercial activity has, for the most part, been left to state and local communities. It is, however, desirable that there be uniform enforcement techniques from state to state and that the local enforcement officials have the best available information on calibration and testing techniques for scales and other measuring devices. In order to accomplish these objectives, the Bureau in 1905 called a conference of local enforcement officials. These conferences have been continued annually since that time, except during periods of national crisis, and they have been a potent factor in bringing about, in the various states, uniform high quality and reliability in commercial transactions involving weights and measures.

A related phase of weights and measures work involved the equipment and techniques for determining the weight of carloads of freight shipped on the nation's railroads. About 1913 it was found that nearly 80 per cent of the scales used to weigh freight failed to comply with the desired accuracy of 0.2 per cent and in some instances, the errors were as high as 20 per cent. The Congress provided special funds which enabled the acquisition by the Bureau of two master railway track scales. These master scales toured the country and at strategic locations checked and adjusted the accuracy of the operating scales. In the first year of the new program it was estimated that the savings, due alone to reduction in administration costs incident to disputes over departure and arrival weights, were substantially more than the cost of the service. The service still continues, and now more than 90 per cent of the scales comply with the required tolerances and the maximum deviations are usually well under one per cent.

Relation of Current Program to Industry

As a consequence of the general growth and change of the Bureau's program during its first fifty years, its basic legislation was revised by the Congress in 1950. There are now six primary functions:

1. The custody, maintenance, and development of the national standards of measurement, and the provision of means and methods for making measurements consistent with those standards, including the comparison of standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government.
2. The determination of physical constants and properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere.
3. The development of methods for testing materials, mechanisms, and structures, and the testing of materials, supplies, and equipment, including items purchased for use of Government departments and independent establishments.
4. Cooperation with other governmental agencies and with private organizations in the establishment of standard practices, incorporated in codes and specifications.
5. Advisory service to Government agencies on scientific and technical problems.
6. Invention and development of devices to serve special needs of the Government.

In addition, the Congress authorized nineteen specific scientific and technical activities in support of the basic functions enumerated above.

STANDARDS FOR MEASUREMENT

The standards currently needed for physical measurement are as diverse and complex as is our modern economy and the sciences upon which so much of it is based. In addition to fundamental length and mass or weight standards and the electrical voltage, current, and resistance standards and temperature standards referred to earlier, there are hundreds of others needed today. Standards for radio frequencies are required to enable broadcasting stations to stay on their assigned frequencies and to enable radio manufacturers to construct equipment which will meet operating requirements. Standard audio frequencies are needed to enable electrical power companies to control the current they supply so that, for example, electric clocks will keep accurate time. Such standard frequencies are broadcast continuously on several bands from the Bureau's stations WWV and WWVH. Illuminating engineers need standards of light intensity, gloss, and reflectance. The effective matching and control of color requires measurement techniques and standards.

Pressure measurements and related standards cover a wide range of interests and values, including the minute pressures encountered in high vacuum devices such as electron tubes, the pressures of the earth's atmosphere of importance to weather prediction and aircraft navigation, and the very high pressures essential to many manufacturing processes. Lubricants to reduce the friction encountered in all mechanical devices require viscosity standards for their evaluation and effective utilization.

X-rays, radium, and the new radioactive by-products of the atomic energy era have made possible a great variety of applications in medicine, industry, and science. Their utilization requires measurement techniques and standards which will differ depending on the type of the X-ray generator or the type of radioactive material.

The dynamic nature of a measurement standards program probably has no better illustration than that provided by our two most basic standards —length and mass. The precision measurement and control of length are basic to our mass production industry since these operations are essential to the interchangeability of parts which is the essence of mass production. In fact, industry's competence in mass production has advanced in conjunction with increased precision in gauging techniques. A few decades ago dimensional control to a few ten-thousandths of an inch represented an extreme of precision. Now such precision is almost commonplace and a few branches of industry require dimensional control measured in one-hundred-thousandths of an inch. In order for a manufacturer to achieve such precision in production, he must have reference standards available in his master gauging laboratory that are accurate to better than one-millionth of an inch. This requirement has brought requests to the Bureau that are beyond presently available techniques and even make questionable the adequacy of our present national standard of length, a platinum-iridium meter bar. Much work has been done toward providing a new type of fundamental length standard, consisting of light waves of a single, sharply defined color whose characteristic wave length can be measured with great accuracy. Such wave lengths will probably soon be used to define a new fundamental standard of length of greater accuracy than the meter bar.

The determination and control of small amounts of impurities in materials has become a necessity in many branches of industry such as metallurgy, atomic energy, and electronics. Such control has required the subdividing of our mass standards with ever increasing fineness and accuracy. The Bureau recently developed a set of micro weight standards for use with precision micro balances. These tiny, mass standards, ranging in size from 100 milligrams to 50 micrograms, permit direct substitution weighings with accuracies of a few tenths of a microgram.

PROPERTIES OF MATERIALS

The Bureau's work on properties constitutes a major part of its research program. The results provide much basic information of direct importance to the nation's scientists and engineers and at the same time contribute directly to the Bureau's competence to develop improved standards for measurement.

Compilations of data on the properties of materials facilitate the design work of engineers and the exploratory work of scientists. The monumental *International Critical Tables* was edited by a member of the Bureau's staff and many other staff members contributed to this important compilation. Data on the properties of steam which are needed for the efficient utilization of this material were compiled by the Bureau. A series of publications on the properties of building materials, totalling nearly 150 over a twenty-year period, have provided valuable information to architects, builders, and manufacturers of building materials.

The Bureau's Standard Samples Program ties its work on properties of materials to its standardization activities. This program is of direct importance to industrial efficiency. The Bureau annually issues more than 20,000 standard samples from its inventory of more than 500 types of standard samples. These samples guard the quality of the steel industry's output; standard pigments define the color of paints; and standard hydrocarbons control the complex mixtures that go into petroleum products such as gasolines for cars and airplanes. Standard cement samples enable manufacturers to standardize their fine mesh sieves. Standard samples also control the quality of synthetic rubbers made by industry.

In general, standard samples are employed to calibrate such instruments as mass spectrometers (used by industry, for example, to control cracking of petroleums) and to check analyses made in industrial laboratories. In analytical research work they serve to standardize solutions and make possible more rapid and uniform testing methods.

METHODS OF TESTING

Methods of testing materials and devices provide primary tools for the development and evaluation of new products and techniques. Although the Bureau's work in this area is geared primarily to aid government in the evaluation of things of direct interest to its needs, the Bureau's contributions to methods of measurement have had a direct influence on the measurement techniques of importance to industry. One example of the extent of this influence is shown by the Bureau's contributions to the work of the American Society for Testing Materials. Bureau staff members participate in the work of most ASTM committees and hold altogether more than a hundred memberships. In addition, Bureau staff members provide direct leadership through chairing many of the key committees, and three members have been elected to the presidency of the Society. The results of many Bureau investigations have been published by the ASTM.

Annually the Bureau publishes several score of items relating specifically to new or improved methods of measurement. These will range over all major fields of science and technology. During 1954, for example, some of the contributions included: a laboratory method for measuring the corrosive effects of soils on metals, an improved method for determining the viscosity of rubber materials, an automatic method for checking rapidly the weights of coins, an electronic device for measuring accurately the altitude of an airplane near to the ground, a rapid method of determining the quality of large internal pipe screw threads, improved methods of checking the accuracy of metering techniques used in fuel gas pipe lines, an improved method of measuring moisture content, a new method of evaluating optical images, instruments measuring the thickness of metallic coatings, a portable meter for determining the rate of air infiltration into buildings and rooms, an instrument for determining the temperature of turbine blades during operation, and finally, applying the techniques of the physical sciences to medical problems, an instrument to measure and record automatically information on the changing physical condition of a patient during a surgical operation.

Each of the first three of the Bureau's statutory functions relates directly to instruments and the science of measurement. The third function is essentially a definition of some specific purposes of measurement. The first function defines the standards which are necessary to give general meaning to the results of measurements. The properties of materials are determined through measurement, and in turn, a better knowledge of the properties of materials makes possible better instruments and measurement techniques and more reliable and accurate standards for measurement.

Hence, the first three Bureau functions derive their major significance to industrial progress from the importance of the science of measurement itself to that progress. The significance of the latter can be demonstrated in many ways, such as the increased importance of research and development laboratories as parts of industrial establishments, the increased use of instruments to control production processes, and the tremendous growth of the instrument industry itself. Fifty years ago there was a bare handful of companies devoted to the manufacture and sale of instruments. Now there are over 2000 firms either devoted entirely or with major divisions devoted to the development, construction, and sale of instruments having a value of well over $1 billion annually. The availability of these instruments has been a major factor in the development of an economy where approximately half of the people now engaged in the production and sale of manufactured goods are dealing with products generally unheard of fifty years ago.

CODES AND SPECIFICATIONS

The Bureau is assigned no direct responsibility for such standards of practice as codes and specifications other than one of cooperating with other agencies, either government or private, that have such responsibility. The background of the Bureau's work in this area was described earlier; at the present time the Bureau's cooperation with the American Standards Association and the General Services Administration (which has general responsibility for government procurement) comprises its primary effort. Such cooperation is, however, quite extensive; Bureau staff members hold about 250 memberships on sectional committees and subcommittees of the American Standards Association and the Bureau serves as sponsor for about 15 important ASA projects, and Bureau staff members participated in the preparation of more than 200 of the Federal Specifications which were promulgated by the GSA in 1953.

The major contribution of the Bureau in the development of codes and specifications is in the acquisition of technical data on properties of materials or testing techniques that are essential to the development of a meaningful standard. Aside from extensive work on building and plumbing codes and screw thread standards, much of the effort relates to safety codes. The National Electrical Safety Code was referred to earlier. Others include elevator safety codes, protective goggles, fire resistive properties of building materials and structures, alarm devices, and fire extinguishers. A major safety program of rather recent technological importance involves the use of X-rays and radioactive materials. In cooperation with the National Committee on Radiation Protection, the Bureau has developed and issued an extensive series of handbooks establishing recommended procedures for handling safety equipment and materials which produce these potentially hazardous radiations.

ASSISTANCE TO OTHER GOVERNMENT AGENCIES

The Bureau's developmental activities for other agencies of the government have resulted in a number of new products and techniques which provide opportunities for American industry. Sometimes these opportunities are limited to the manufacturing of new devices to serve the special needs of government, but often the developments have a wide application to the civilian economy.

Earlier reference was made to the Bureau's war work with optical glass and proximity fuses. The former activity was a major factor in establishing in America a vigorous optical glass industry; the latter activity led to the development of printed electronic circuits and circuit miniaturization techniques which are having an important impact on the electronics industry.

It would take many pages to list the Bureau developments which have led to new products or techniques in industrial plants but a few additional illustrations may suggest the scope and importance of such contributions, most but not all of which came out of work for other government agencies. A few earlier contributions included: a method of heating the filaments in radio tubes with alternating current so that the earlier battery-operated radio receiving sets became obsolete; basic work on methods of quenching steel, and on methods of preventing crazing on glazed ceramics; the basic method for producing heavy water electrolytically; basic data on the characteristics of air turbulence on aircraft structures; strain gauges for measuring the deformation of mechanical structures; and greatly improved materials for dental alloys.

Some more recent developments include: a magnetic fluid clutch, representing a new method of controlling the transmission of mechanical energy; an electroless method for plating nickel, using chemical action; a method of making paper from glass fibers, which paper has unusual properties as an air and gas filter; a ceramic coating for protecting metals exposed to corrosive hot gases, of particular importance in aircraft parts but apparently with a wider range of applications as in certain domestic gas burning appliances, and a method of electronic design which with suitable equipment makes possible the mechanized production of electronic equipment.

The Bureau operates a Central Radio Propagation Laboratory, established on an emergency basis during the war to provide vital data on conditions affecting radio communications. The laboratory was reorganized after the war to serve on a continuing basis all other government and private groups concerned with radio communications. The CRPL operates a widely dispersed series of field stations which make observations on the characteristics of the upper atmosphere that influence the effectiveness of radio communications. These data are analyzed and disseminated much in the manner of a radio "weather" forecasting service. In addition, the laboratory does research on radio propagation and has made substantial contributions to new and improved techniques for radio broadcasting and receiving and to more efficient methods for utilization of the highly sought space in the radio frequency spectrum.

In another area the Bureau provides mathematical computation services to other government agencies and has done pioneering work in the application of electronic techniques to the rapid processing of large quantities of data. As an example, the Bureau served as a focal point for pooling the interests and requests of the first three government agencies that acquired modern, commercial, high-speed, automatically-sequenced, electronic computing machines: the Census Bureau, the Army Map Service, and the Air Comptroller. The Bureau also built earlier a machine for its own needs, the SEAC. In addition to its role in solving a number of important mathematical problems, the SEAC has been used in pilot studies of large data processing requirements of other government agencies.

DIRECT COOPERATION WITH INDUSTRY

The Bureau cooperates directly with industry groups in several ways such as visits and correspondence on specific technical problems and through membership on professional society committees. One of the most fruitful activities has been the Bureau's research associate plan started thirty-five years ago. The plan provides for the use of the Bureau's facilities by a sponsoring industry group on projects having both a specific industry interest and a broad general interest. While the arrangement is preferably made with an association or group representing a major part of the industry concerned, projects for single companies or individuals may be undertaken when the results are expected to be of public value. In any event, the results become part of the public domain and are published by the Bureau.

The Portland Cement Association research associate project, started in 1924, offers a good example of the beneficial results received from the research associate plan. Quick-setting cement, which reduced from 48 hours to 7 hours the time a highway has to be closed after the concrete is poured, came as a result of the Association's project at NBS. Through analysis of the effect of the various constituents of cement on its physical characteristics, the early strength cements used for Boulder Dam were also developed.

More than 175 trade and industrial associations, individual industries, philanthropic institutions, and individuals have sponsored research associate projects at the Bureau. In all cases the results have been of direct benefit to both the nation and the sponsoring industry or group.

CONCLUSION

An excellent summary of the significance of the National Bureau of Standards for industrial progress is provided in the report of an Ad Hoc Committee appointed by Secretary of Commerce Sinclair Weeks in 1953 to evaluate the functions and operations of the Bureau in relation to present national needs. The Committee, under the chairmanship of Dr. Mervin J. Kelly, President of the Bell Telephone Laboratories, included representation from the nation's leading scientific and engineering societies. The Committee found:

> The functions authorized for the Bureau of Standards are of great importance to national welfare. As our society becomes increasingly industrialized, these functions assume even greater importance and the work of the Bureau in meeting the obligations of its assigned functions becomes more highly scientific, broader in scope and more complex in organization.
>
> In a society whose welfare is so dependent on applied science and technology as is our own, it is most important that the Government carry out those functions in support of science and technology that are uniquely in its province in the most effective manner possible and that a sufficiently high level of effort be maintained to insure an adequate coverage of the area of responsibility. It has placed broad and important functions in this area with the Bureau.
>
> The scope of coverage of the first four broad functions [of the six statutory functions] must be adequate to meet the needs of our advancing technology. Physical constants, the properties of new materials, the development of methods for their testing and their early incorporation in codes and specifications are vitally important to our highly industrialized society. The Bureau's work on the "new" should as a minimum keep step with the pace of applications of the "new" by industry. For its full effectiveness it must not lag.
>
> The remaining two, while more restricted in scope, are properly placed with the Bureau; for with its organization of experts in science and technology and their special technical facilities, it is fitting that the Bureau provide advisory service on scientific and technical matters to other Government agencies and, where uniquely indicated, to develop special devices to serve their needs.
>
> It is the Committee's considered judgment that our highly industrialized society requires a Bureau of Standards that is the finest that can be created. To the extent that the Bureau is weak or inadequate, our technologic society is handicapping itself. By the very nature of its functions the Bureau's work must not be "reasonably good," it must be superior. It is not sufficient to have fairly good standards of measurement; fairly good methods of testing materials, mechanisms or structures; or reasonably good determination of important physical constants. The standards, the measurements, the test

procedures must be the very best, the most accurate, the most reliable that can possibly be achieved at any given time, limited only by the state of the art at the time. It is thus more than a play on words to say that the "standards" by which the Bureau is judged must be the very highest and best.

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7. LIBERATING RESEARCH AND DEVELOPMENT WITH NATIONAL STANDARDS

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NATURE OF AND NECESSITY FOR STANDARDS

Standards, like habits, are an indispensable aid to the life of man. The most basic standards perform for us in social and economic activities services similar to those performed by habits in our personal life. We would not be able to work and to accomplish without them.

By the development of habits, the mind of man is liberated from the necessity of being preoccupied with a vast number of minute and unnecessary decisions. The child, which at first must concentrate all attention on efforts to stand or to walk, soon learns to make habitual the proper exercise of the muscles for these functions and can concentrate his attention on other things. This is but an elementary example of the fundamental place which habit holds in the life of mankind.

Similarly, how could we carry on commerce and industry without standards for the measurement of length and of weight, and without coins which are standards of value? Or for that matter, how could a social world exist without speech? Speech consists of the standardization of complex groupings and combinations of sounds produced by the speaking voice. The standardization of these sounds has been carried far enough to enable them to convey a large degree of understanding between considerable groups of the human race.

Speech illustrates, however, one limitation which we find repeatedly in the world of standards. Standardization has not been carried far enough. Even between the Americans and the British, who profess to speak the same language, the standardization is incomplete and misunderstandings are all too frequent.

The history of the progress of man is studded with advances in standards, and is cluttered with many cases in which standardization has been too late. This is true even in so elementary a thing as standards of volume.

Our grandmothers used recipes calling for a cup of milk, butter the size of a walnut, a teaspoon of this and a pinch of that. It is only in 1950 that satisfactory standardization was completed in this country of the cup and the teaspoon, and other kitchen utensils.

RELATION BETWEEN RESEARCH WORK AND STANDARDS

One way in which standards liberate effort for research work was pointed out thirty years ago by Albert W. Whitney, then Chairman of the Engineering Standards Committee. "Standardization," he said, "relegates the problems that have been already solved to their proper place, namely, to the field of routine, and leaves the creative faculties free for the problems that are still unsolved."

This is true, and is only the beginning of the relationship between standards and research work. Standards are born of research work. As knowledge is pushed into new fields, it is necessary to define new terms describing new things, new ideas, new qualities or relationships. For example, in acoustics there has been a lack of agreement on the meaning of the terms "ultrasonics" and "supersonics." "Ultrasonic" has now been defined by the National Committee on Acoustical Terminology as sound in the frequency range above 15 kilocycles per second, and "supersonics" as phenomena associated with speed higher than the speed of sound. In the rapidly advancing field of nuclear science, a new standard has recently been agreed upon, defining 2000 terms. Examples could be multiplied indefinitely which illustrate the need to standardize new terms to help research work.

Also, as research determines more exactly new relationships and new quantities, it is necessary to develop and standardize new methods and techniques of measurement. In some applications of polyethelyne great importance attaches to the molecular weight of the material because it affects the mechanical characteristics of the final product. In developing the use of this material for cable sheaths in place of lead, therefore, it was necessary to develop and standardize new methods of determining the molecular weight of the raw material.

In a great many cases, therefore, the development of new standards is an essential part of the advancement of research and development work toward its chosen aim. In some cases, however, new standards themselves are the aim toward which the work is directed. Often research and development work must be done to develop new standards which are needed to bring about a technical advance in industry. This is well illustrated by research work over a considerable period on standards for cast-iron pipe, directed toward the improved performance of this product. It is so important today in the development of improved materials for gas turbines that Dr. W. J. Harris, Jr., in a recent article states, "Metallurgical research groups of the country look on standards as the end products of research."[1] To support this, Dr. Harris refers to the development of the Brinell test as a standard for the measurement of purity of titanium, to research in high-strength high-temperature alloys, and the attempt to reduce the more than 300 alloys now being used to about 50 standard alloys in order to increase supply and insure satisfactory operation.

RELATION BETWEEN DEVELOPMENT WORK AND STANDARDS

It is not necessary to attempt to define in this discussion the nebulous line between research work and development work, but in using the term "development work" I want to call attention to the relation between standardization and the design of new products which become possible as the result of research.

For economical design, a new product must make wide use of standard machines and tools, manufacturing processes, and materials. For example, it is reported that in a Navy contract the screws which were specified were not standard, and consequently cost eleven times as much as the standard screws which could have been used.

An extensive standardization of machine tools and materials is of great value to the designer in enabling him to select the form of design, the materials, and the manufacturing processes which will result in as low a cost as possible for his new product.

In new products there is an increasing use of standard components. For such components, when they are adequately standardized, the designer knows the denominations, the dimensions and other physical characteristics, the precision and stability of the item. There generally is assurance of the continued availability of standard components, and often assurance of competitive prices. Such standard components would have been of great advantage in the early days of radar and other electronic gear when a tremendous problem of maintenance developed in cases where insufficient consideration had been given to standardizing the components and building into them adequate safeguards for precision and trouble-free life.

The same considerations apply to the standardization of materials. Adequate standards which provide for uniform materials of suitable properties are essential to the good operation and low maintenance of many new products.

STANDARD PROCESSES AND PLANS

There is a wide range of research and development work which is aimed toward the development of new processes or of basic plans rather than of specific products. These new processes and basic plans in themselves may constitute new standards of broad importance.

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[1] W. J. Harris, Jr., "Control of Metallurgical Standards," *Standardization,* Vol. 24, no. 5 (May 1953), p. 133.

The function of plans as an instrument of standardization can be illustrated by a plan recently developed by the telephone industry of the nation in cooperation with its research and development organization. This is known as the Nation-Wide Telephone Toll Switching Plan.

Until a few years ago, the switching operations involved in long distance telephone service were for the most part carried out manually by operators on the long distance switchboards. With great developments in telephone switching equipment, in facilities for providing long distance circuits, and in the demand for telephone service, a study was initiated some years ago to establish a plan for the future switching of long distance circuits by mechanical switching systems.

As a result of this work, a fundamental plan was established which provides (1) for the immediate rapid extension of a type of operation in which the long distance operator at the originating end of the call completes the call to the distant telephone entirely by machinery, and (2) for the ultimate wide extension of a method of operation in which the customer dials direct the desired number and the call is completed, even nation-wide, without the intervention of any operator.

Advancing these far-reaching fundamental plans involved a great deal of standardization. First and most basic was the standardization of the plan itself. This involved standards in a broad range of subjects necessary to implement the plan. These standards include:

1. The two methods of operation: operator dialing and customer dialing of long distance calls, briefly described above.
2. A standard numbering plan, providing for long distance calls telephone numbers which will not be duplicated throughout the entire country.
3. Standard features of the toll switching machines. This includes the features necessary to enable the machine to accept information concerning the telephone number of the distant telephone to which the call is directed and to provide itself with all the necessary information as to the route to be followed in reaching that telephone. Also, a basic feature is that the machine will work out a succession of alternate routes in the event that the route first tried does not have any free circuits.
4. Standardization of a basic trunking plan which provides in a systematic way for the cooperation of switching units throughout the country as required to establish a complete circuit between two telephones over the best route available at the moment.
5. Determination of the location and type of important switching centers throughout the country in accordance with the standard trunking plan.
6. Standardization of the specific features which had to be developed for the switching machines in order to carry out the functions required in accordance with the plan.

This is a large-scale project and a rather elaborate illustration of the relation between standards and development and research in this field of basic planning. This toll switching plan sets standards which have formed the guide for much research and development work over a term of years, and which will direct the engineering of new installations and expenditure of many hundreds of millions of dollars throughout a long period in the future.

STANDARDIZATION AND ACCEPTANCE OF THE RESULTS OF RESEARCH

Standardization hastens the acceptance and use of the products of research and development work. This effect is present in different degrees with different products. Most people, except drivers of "hot-rods," prefer a standard automobile because they are assured they can secure replacement parts and maintenance skills. People would not buy freely the new types of plastic hose if they were not assured that the fittings would fit the existing taps and nozzles so that they could be used without inconvenience.

In some cases, however, standardization is even a condition precedent to the design of the product. Television offers an illustration of this fact. In order that the television industry might advance, it was imperative that standards be established of frequency, of numbers of frames per second, of numbers of lines per frame, of degree of definition, and other technical matters. This was necessary so that the receiving set built by any manufacturer would be able to receive television images from a transmitting station also built by any manufacturer.

The requirements for standardizing are multiplied with the introduction of color television. To meet the same requirement that any receiving set could operate in connection with any transmitting station, a far more complicated set of technical standards is necessary, since there are many possible forms of color television systems. Furthermore, it is deemed desirable that the standard be such that a color television receiving set will produce black-and-white pictures when receiving from one of the present standard black-and-white transmitting stations.

Through the instrumentality of a committee representing the television manufacturing and broadcasting industries, with the cooperation of the Federal Communications Commission, these conditions have been met most successfully. Standards have been recently established for color television which are permitting this branch of industry to start on a large scale, with every hope of a brilliant future.

NATIONAL STANDARDS

So far, I have been speaking of standards in general terms. In the extreme case, what I have said might apply to the lone worker in a new field who establishes his own standards. Commonly, however, in using the term "standardization" we think of a much broader field. How is it to be determined what breadth of field is necessary or desirable in a given case?

It is not difficult to establish some general principles. In order to be effective, a standard must be generally acceptable to all the groups which are concerned with its use. That means, in the case of a material thing, all concerned with the design, manufacture, distribution, use, or public effect of the thing involved. The breadth of agreement necessary for an effective standard, therefore, depends on the breadth of its impact on our social and industrial life.

In our present day and age, this criterion points to the desirability of standards of at least nation-wide scope in a large proportion of cases. Most of the results of research and development work are such that a great many persons and groups are in some way concerned with them. To be most effective these results require a common understanding on the part of the interested persons and groups throughout the country. Hence, standards of national scope are clearly necessary. The same applies to the many instances where for maximum usefulness a product must be interchangeable, as, for example, in the case of lamp caps and holders. As has been pointed out above, standardization of function and of quality is important in making a new product attractive to the maximum number of prospective purchasers. Here again national standardization is necessary.

To go to the other extreme, we may consider the simple product of a single manufacturer not requiring physical coordination with anything already built. In such a case, standardization is still important so that the customer will have adequate assurance as to the functions and quality of what he is buying and as to the replacement of the product or its parts. As long as the product remains unique, the internal standards of the one manufacturer may be sufficient to meet this requirement. However, the new products for which this condition persists would appear to be a relatively small part of the production of new things in this country.

INTERNATIONAL STANDARDS

The considerations which apply to national standardization apply also to the determination of the cases in which international or world-wide standards should be sought. It is seldom that there would not be some advantage in having standards world-wide instead of nation-wide. In determining whether to seek world-wide standards, however, it is necessary to recognize that, generally speaking, the development of international standards is more difficult, more time-consuming, and more expensive than the development of national standards.

It is also to be borne in mind, however, that once national standards in different countries have developed along divergent lines, it is far more difficult to bring them together later than it would have been initially before the national standards had been crystallized. For this reason, a special consideration should be given to the applicability of international standards to the new products and new processes which result from research and development work. If international standards will be needed eventually, it is of great advantage to launch them at as early a stage as possible. In this country, the American Standards Association provides unparalleled facilities for arriving at national and international standards and for insuring that in the process all parties at interest have a voice.

SUMMARY AND CONCLUSION

To one not fully informed, the term "standards" may seem to imply the process of freezing products or processes into prescribed forms, thus hampering the development of new things. We have seen in the discussion above that, on the contrary, standards in appropriate fields are a great force in liberating research and development effort. The principal effects of standards in this direction may be summarized as follows:

1. Standards relegate the problems that have already been solved to the field of routine, and leave the creative faculties free for the problems that are still unsolved.
2. Standards provide the necessary means of communication for the establishment of understanding between workers in the same field. This helps to open to the research worker a knowledge of the work being done in the country and in the world.
3. Standards provide a degree of definiteness and precision for new methods of measurement and other new techniques necessary to permit accurate comparison of results and the drawing of sound conclusions.
4. In many cases, technical advances in industry require the development of new standards which themselves are the source of research and development projects.
5. Standards help designers to develop new products in such a way that they are attractive from the standpoint of cost and maintenance. Standard materials, machines, tools, processes and components having known technical and cost characteristics are essential to this end.
6. The proper coordination of long programs of development requires the establishment of basic long-term plans. Such plans constitute standards or groups of standards of great value in coordinating groups of research and development projects and guiding them into the directions pointing toward the most fruitful results.
7. Standards hasten the acceptance of the results of development and research work.

From this impressive list of the ways in which standards liberate research and development effort, we may conclude that they are of as great importance and necessity in this field of human activity as they are in other social and economic activities of mankind.

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8. STANDARDS AND AUTOMATION

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INTRODUCTION

THE MOST DOMINANT feature of the present technological age is its unprecedented rate of change. At few times in man's history has there been such a ferment and never before has there been such a searching toward new ways of doing things, new processes for producing new and better materials, new techniques developed in keeping with the changes they themselves are producing. The leaven of this ferment on the world scene is industrialization and mechanization, while in the more advanced industrial countries the roots of the ferment lie in the new technological revolution labeled "automation."

Although the word "automation" was originally used by D. S. Hurder of the Ford Motor Company to describe a mechanical handling of materials (more recently dubbed "Detroit Automation"), its newer meaning is much broader, for it now signifies the ultimate goal of the industrial revolution, that is, a complete machine technology. It has been defined with this connotation by M. H. Aronson, of *Instruments and Apparatus News,* as follows: "Automation is the substitution of mechanical, pneumatic, hydraulic, electric, and electronic devices for human organs of decision and effort."

Although we are far from a completely automatic industrial system, this new technological pattern has already come to dominate many branches of the chemical and processing industries; it is also aspiring to usurp the techniques of accounting, inventory taking, billing, mailing, etc., of the large business houses. In manufacturing and distributing fields systems of automatic machines with automatic controls, automatic conveying, assembling, inspecting, packaging, to mention only a few of the automatic processes, are being used in the mass manufacture and distribution of products.

The technical, economic, social, and managerial implications of the impact of automation on our society have led some people to identify our age as the Second Industrial Revolution. It is claimed that the First Industrial Revolution freed man's brawn; this Second Industrial Revolution frees his brain from the tedium of routine tasks. The social and economic results of this freedom may mean unemployment, or shorter hours of work, a new leisure to contend with. The crying need for engineers and technicians to accomplish the automation revolution requires expanded educational programs for our schools and colleges; a program for upgrading or retraining the displaced workers for new or different jobs may need to be developed.

These examples are representative of the complex and challenging problems presented by automation. In all the domains that are encompassed by automation revolutionary changes are occurring. This article proposes to look at the field of standards which has been so vital to industrialization, and try to estimate the effects of automation upon the philosophy and the techniques of standards. How will such concepts as "standard part," "standard length," "standard process" be affected by automation? What will be the role of standards in the success of the new technological revolution—automation?

Role of Standards in Our Industrial System

A study of the historical development of our present industrial system presents six or seven key conditions[1] that have made the present technological level possible. These are an abundance of cheap metals and raw materials, cheap machinery, high speed heavy machinery with adequate lubrication, electric power, specialized production, assembly-line and mass-production techniques. In the last three developments the role of standards has been vital. The successful production of interchangeable parts has been conditioned by standards as to size, composition of metals, techniques of processing, language, symbols, etc. The major part of these standards has been developed by companies for their own use; national standards exist for only a few specialized products. Nevertheless, our present technological level can be said to be based, given the seven conditions mentioned above, on a system of standards.

The logical extension of such an industrial system culminates in an automatic plant. With the application of feedback, electronic regulation, and automatic control to the assembly-line and mass-production techniques of an industrial or business enterprise, there evolves the completely automatic plant. Just as the logic of industrial development leads to automation so the logic of standards seems to lead to a broader system of standards.

[1] As outlined by Professor Robert A. Brady in an unpublished manuscript.

Standards and Automation

A STANDARDS REVOLUTION

The facet of automation with which we are now concerned is the relationship of the techniques of automation and the concepts of standardization, standard parts, standard components, and the related concepts of specifications. What are the implications of automation in this field of "standards and specifications"? How must our system of standards be broadened to meet the challenge of automation? The answer to these questions is that the smooth transition to automation requires a great extension of the system of company standards, industry-wide standards, national and international standards. In fact automation requires a standards revolution. Evidence of this is seen in the industries in the forefront of automatic production, particularly in the field of mechanical and electrical controls. Illustrative examples are given in the next section. In this field during the past five years three agencies have been preparing standards for automatic control, computers, data processing, and programming. This work has produced "Automatic Control Terminology" of the American Society of Mechanical Engineers; "Standards on Electronic Computers" by the Institute of Radio Engineers; "First Glossary of Programming Terminology" by the Association for Computing Machinery. The American Standards Association which acts as a clearing house for the establishment of national standards is preparing its "Automatic Control Terminology." The British Standards Institution, functioning in a similar fashion, has prepared "Automatic Controlling and Regulating Systems."

Significant as this work may be it is nevertheless true that the present state of standards in relation to automation is chaotic. The need is recognized for a great extension of standards to fulfill the promise of automation, but on the other hand in this rapidly moving field new parts frequently become obsolete before they can be standardized. Old standard parts are made obsolete by new techniques and inventions. This general chaotic picture is nowhere better emphasized than in the electronics industry.

STANDARDS IN THE ELECTRONICS INDUSTRY

The automation revolution is necessarily based on the electronics industry which is itself just beginning to apply automatic production techniques. It is in the electrontics industry that we find the best example of the present gropings for new techniques of production, for new standards in raw materials, in component parts, in terminology. The electronics industry will probably be called upon to increase its present production tenfold in the next five years. To accomplish this feat it is imperative that the industry resort to automatic techniques.

Coupled with this unprecedented growth of the electronics industry is a similarly unprecedented development of new components and techniques (such as carbon and resin mixtures to form resistance elements on a ceramic base, transistors, miniaturizing of components) along with the rapid obsolescence of parts, methods and even the men who design equipment. For example, the use of transistors in miniaturizing control equipment calls for men specialized in this new branch of electronics or for a retraining of the men skilled in vacuum tube techniques. In the development of digital computers a technique of electro-static memory was made obsolete before it was perfected by a new technique of magnetic storage.

It is in such a maelstrom of activity that the standards of the new age of automation must evolve; for indeed the standard component or subassembly is the keystone of our advance into the automatic age. (The concept of "standard components" must be broadened to include anything from a drift pin to an automatic milling machine, from a stripe of silver conductor painted on a printed circuit to a digital computer capable of 10,000 multiplications a second.)

It is these standard packaged subassemblies that are the plug-in units of the automatic controls of the new automatic factories. By the techniques of the new "systems engineering" (see next section) the standard packages can be integrated into a complex working unit. As an example, let's turn to electronic analog computers as viewed from the research mathematician's point of view. He knows that the computer will solve the differential equations of motion of the guided missile he is studying by plugging together the standard components of the computer, the integrators, the multipliers, the adders, etc. Each of these components is a "little black box" that performs the required operation with the necessary accuracy in the specified number of milliseconds allotted in order to guide the missile on its course. The mathematician need not know that the integrating capacitors have an accuracy of 0.1 per cent or that the multipliers work on the principle of time sampling with a speed of microseconds. He must know only that one black box multiplies, another integrates, etc. So while the amplifier itself is made of standard parts, these must themselves be arranged into a standard unit which must occupy a place in some new system of standards. This concept has led to several research projects which are probing the possibilities of automatic production of electronic subassemblies.

Government and industry contribute to this effort by sponsoring at least two dozen experimental automatic production lines. These projects include work at Stanford Research Institute in development of automatic assembly techniques for miniaturized electronic equipment; at Mel Par, Inc., in the automatic production of electronic packaged subassemblies; at the National Bureau of Standards on modular design and the mechanized production of electronic subassemblies.

The researches in the field of automatic production of electronic equipment are enforcing closer working relations between the researcher, the design engineer, the plant economist, and the production line specialist. Techniques that are being developed for overcoming the processing and fabricating difficulties in the electronic field are being made available for other fields of automatic production.

The most important problems that have arisen in the automatic production of electronic equipment are those of quality control and product testing. It is in this realm also that a fresh approach to the questions of standards and specifications must be made.

In the design of automatic production equipment the product itself must often be redesigned to make automatic production possible. As an example, we can cite the experience of Western Electric. In an attempt to produce an automatic assembly line for a particular relay, the product was redesigned for automatic production. The result was a new and better relay.

SYSTEMS ENGINEERING AND NEW CONCEPTS OF STANDARDS

Design of automatic production equipment often requires a "systems" approach where a team of engineers must work on the over-all problem for adequate solution. This could well lead to a revolution in design.

This technique of "systems engineering" (the over-all design of an automatic process) as applied to consumer goods involves an approach that is already a well established technique for attacking the complicated research problems encountered in the military field. The "systems" approach has only recently been applied to automatic production. A team of experts in several related fields of product design, cost analysis, automatic control, instrumentation, production-line techniques, and so on, analyze the problem together and make use of the latest assortment of "packaged" units for the design of the automatic production line. The automatic controls man will furnish the power supplies, the computing amplifiers, the servo-systems that have become standard units in the know-how of the controls engineer.

The production-line man will have at his command various standard automatic machine tools such as the automatic lathe, drill press, or milling machine. These may be the flexible short-run type with the "play back" tape for continuing a run after the operator has performed the operation manually, or the more inflexible machine programmed for a long run on a single operation. These machines can also be thought of as standard equipment capable of being operated by a standard tape control which is punched in a central taping office to the engineering specifications. The expert on product design will have at hand the new process techniques such as printed circuits, powder metallurgy, electronic and supersonic tools and instrumentation.

Here are new concepts in design coupled with new concepts of standards both of which must be applied to the new approach toward production techniques enforced by the new technological revolution.

NEW CONCEPT AND STANDARDS OF TESTING AND MEASUREMENT

Automatic testing often presents the problem of what physical characteristic of a product will best serve the needs of quality control and reliability. The basic physical standards of length, mass, and time can be measured by electromagnetic waves such as light, X-rays, defraction gratings. Weight can often be substituted for other measurements such as length, concentricity. The advent of automation has led to a host of new measuring and conversion devices which will convert pressure to a number, length to a voltage, plating thickness to a number of high frequency wavelengths, quality of a metal to radiation passage.

Automatic testing in process is essential to the continuous flow of the product. This, coupled with the feedback concept to allow automatic correction for wear, for variation of raw material, or changed products, leads us to the ideal of the industrial age—the complete automation of a process from raw materials to the finished product, from iron ore and other basic materials to the finished washing machine or automobile.

An interesting example of a new testing technique is nuclear gauging which is rapidly becoming part of the closed loop techniques of modern production. In the production of tire fabrics the rubber coating is measured by a continuous ray gauging technique. The measurement is made by sensing the radiation passage through the material. A recording device classifies the material as premium, good, or reject. The sensing device is in the control loop which is capable of correcting and keeping the fabric to the desired thickness.

The design of automatic instruments must be approached from these viewpoints: What do we want to know? How accurate must the answer be? How is the information to be used? The new tools of the controls and instrument engineer are capable of microsecond timing and micro-inch precision. The high speed computers and data-handling devices, the optical gratings and nuclear gauges are the standard parts of controls system.

The new approach to automatic instrument design involves the recognition of a new communication chain. The old chain, "instrument-operator-process," with its complicated and slow-speed translating devices, such as gauges, color charts, etc., is replaced by the new chain, "instrument-control panel-process," in which there is a common language of communication between all the components. This eliminates the slow-speed translator elements and insures high-speed accurate control impossible previously because of the human operator in the chain. The new language of communication will be understood in terms of information theory, cybernetics, linear programming, and the theory of games.

SIMPLIFICATION OF COMPONENT PARTS

One important aspect in this field of automatic production of electronic subassemblies for control or computer purposes is the tendency toward simplification. A few rather simple subassemblies can be designed for production by a single flexible production line. In the production of electronic parts for the latest International Business Machines computers, General Mills, Inc. has undertaken to produce all the subassemblies needed for the electronic parts of the computers. The production line is flexible enough to handle the range of components, materials, and designs called for, and can be quickly converted from the production of one packaged unit to another. A testing machine coded with punched cards tests all the different standard electronic packages. This is a clear example of a new standard product, the package itself, one of hundreds in a standard computer. When computers of this or similar construction are used as control units in the new automatic factories there will be need for these automatically produced standard subassemblies for preventive maintenance of the assembly lines of the automatic factories. These features of the new age lead either to monopoly production by a single company or to development of standards for subassemblies that may be produced by different automatic plants. Present evidence of standards development is in the field of synchro transmitters produced for the radar systems of the Army and Navy. Synchros are manufactured by at least five engineering firms to U.S. Government specifications. The U.S. Government is the main customer for many articles of this type. It is evident that the government is playing a dominant role not only in the field of automation but also in what might be called the "standards and specifications" revolution. The government is in a position to present a set of specifications and require that all companies work to them. This eliminates all shades of difference among the products of the several companies, thus actually eliminating the need for several companies when the techniques of automatic production are applied to these products.

EXAMPLES OF THE STANDARDS AND SPECIFICATIONS REVOLUTION

An example of the standards and specifications revolution can be seen in the development of printed circuits. Had it been left to the component assembler concerned with wiring together resistors, capacitors, tubes, etc., to form a package, the new art of printed circuits might not have evolved. It remained for the components manufacturers dealing with the raw materials to take a new approach. Starting with basic carbon, ceramics, resin, etc., they were able to form the circuit elements and the circuit itself in an assembly operation. Conductive patterns were formed by etching, stenciling, or plating to produce the required circuit. In this field a whole new system of standards and specifications has to be developed.

In the two dozen or so experimental production lines of electronic parts, each manufacturer was free to go his own way, to develop his own new processes and components needed in the automatic production. The present efforts toward finding new ways of doing things, new products, etc., are the technique of shotgun approach out of which is expected to develop a best way or a best product that can be used as a standard for the rest of the industry.

As a final example of the standards and specifications revolution we may cite the development of the Rockford Arsenal Shell Plant for the automatic production of 155-millimeter shell casings. The automatic plant was patterned after the nonautomatic plant and based on the old techniques of tooling and turning the casings. The automatic plant produced no saving in cost or time but it did produce casings of high quality. It remained for a new extrusion process to render obsolete both of the previous methods and introduce a saving in cost and production time. This is additional evidence that to insure the maximum benefits of automation it may be necessary to redesign the product.

NEW LANGUAGE

An example of the new language that has become standard for the controls engineer is the phrase "frequency response" with reference to a controls system. From the response of a controls system to a step function input, the controls engineer is able to deduce many of the operating features of the system. "Frequency response" is becoming a design specification for controls systems.

The new word "cybernetics" of Norbert Weiner fame has been used to denote control and communication in man and machine. The word is often used in combination with others, such as "engineering cybernetics," to specify direct engineering application of the broad science of cybernetics.

The related fields of communication theory and games theory are important in linear programming which is useful in calculations to optimize the benefits of certain industrial processes or operations. Other phrases such as "systems engineering," "operations research," "feedback," "transfer functions" have taken on new meanings when used in reference to controls.

CONCLUSIONS

The existing evidence from successful automatic production lines indicates the need for a rethinking of any particular product, as to its uses, its raw materials, its fabrication, etc., if it is to be produced automatically. In some cases the product is redesigned better to fit automatic methods. In other cases the product is no longer needed as a component in a redesigned assembly. Such an approach to the design of automated processes will enforce the development of new standards in products and product design.

A new system of standards must be evolved which is broad enough to include standards for subassemblies such as amplifiers, analog-digital converters, electronic, pneumatic, mechanical control units. The design procedure of systems engineering will make use of this broad concept of a standard part to include even a machine tool or a computer.

Instrument engineers must take a new approach to design. Instead of the old communication chain of instrument-operator-process, the new chain instrument-control panel-process must be substituted, thus eliminating the translator element and allowing the development of a common language for the whole communication chain.

New concepts of quality control are evolving where the statistical approach of sampling may be replaced by continuous quality control techniques. New methods of testing and inspecting must be developed for in-process checking of the products of the automatic assembly lines and automatic factories.

New concepts of allowances and tolerances can be expected to emerge as the automatic machines work at higher speeds and to greater precision than could be expected of a master machinist. The nuclear gauging, optical gratings, etc., of the new measuring devices will make the microsecond and microinch as common as the microfarad.

Although the exact timetable of automation is difficult to foresee, one certainty is the irreversibility of the process once it has started. Automation is the ultimate development in a society which is committed to an industrial way of life.

The fulfillment of the First Industrial Revolution as represented by the technological levels of mid-twentieth-century America was sustained on the supporting framework of standards and specifications. To reach the even higher technological levels envisioned as a result of the automation revolution a similar but vastly expanded framework of standards and specifications will be required.

The present system of standards is already in a revolutionary turmoil because of the impact of automation. However, the prevalence of a "philosophy" of standards, and the universal realization of their need—the net gains of our experiences in the past—will help bring some semblance of order to fulfill the promise of this new technological age.

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9. MODULAR CONSTRUCTION— THE BUILDING BLOCK PRINCIPLE IN ARCHITECTURAL DESIGN

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WASTE IN CONSTRUCTION INDUSTRY

In 1921 Herbert Hoover as President of the Federated American Engineering Societies named a group of engineers to constitute the Committee on Elimination of Waste in Industry. The Committee's classic report, *Waste in Industry,* contained a section on building industry which laid bare the acute shortage of housing on the one hand and the staggering wastes, a large share of them attributable to managerial inefficiency and labor problems, on the other.

At the Research Correlation Conference of the Building Research Institute held in Washington, on December 9, 1954, it was brought out[1] that with standardization of building materials the American people could save up to 20 per cent of the cost of new construction.[2] (The saving is an ultimate goal and could probably be obtained only with complete standardization.)

In the intervening years between these two reports there have been many others of a similar nature. The waste in building construction is evident to a casual observer; to those who have critically studied the industry, the waste is revealed in its full enormity.

All this has raised the obvious questions: "Why can't something be done about it? Why not standardize building materials so that this tremendous waste would be eliminated?" A most laudatory objective; its achievement would not entail any sacrifice, and the money saved would be sufficient to operate all our institutions of higher learning and have a surplus left over.[3]

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[1] *Modular Measure,* The Edited Papers and Discussions of a Research Correlation Conference entitled Modular Coordination: Its Value in Contemporary Building. Conducted by the Building Research Institute at the National Academy of Sciences, Washington, D. C., December 9, 1954, p. 50.

[2] In 1954 the cost of private construction in the United States was $25,768 million, and of public construction $11,809 million (*Construction Review,* Vol. I, no. 9 [September 1955], p. 13). Assuming that the total value of new construction in 1955 was over $40 billion and the value of buildings—the construction of which offers the greatest opportunities for savings through standardization—was $25 billion, a saving of 20 per cent would mean a saving of $5 billion.

Unlike most standardizing problems that are considered by the various standards groups in the United States, the standardization of building materials involves not one but hundreds of different items; it affects thousands of manufacturers and millions of men who perform the actual construction work. The extremes of climatic and geographic conditions, and the varying patterns of construction practices in different communities and sections of the country, must be given due consideration. Most of all standardization requires a basic formula on which all can agree, a formula that can be applied to many different materials, to varying manufacturing processes, and a formula so simple and practical that it will warrant general acceptance by the entire industry.

BUILDING TRADITIONS AND UNCOORDINATED STANDARDS

To realize the tremendous problems involved and the building habits that must be re-oriented, it is only necessary briefly to review the building traditions that we have inherited.

The basic concept of construction, until at least the beginning of the nineteenth century, was a concept based on the use of natural materials. Stone of all kinds, marble, clay products, and wood were put together to form walls which supported floors and roofs, generally of wood construction. These materials were amenable to cutting and fitting at the construction site to any reasonable size or shape, and could be combined as required with comparatively few tools, but with considerable labor on the spot, to produce a satisfactory structure. The use of lintels of wood, or masonry arches, permitted forming the necessary openings to admit light and air. One of the few pliable products employed in the early construction was plaster, and the application of it was dependent on those limited provisions which could be made to form a satisfactory base or anchorage for it.

With the improvement of saw mill machinery and mass production of nails in the early nineteenth century the laborious system of house framing with mortise and tenon began giving way to the "balloon frame" construction which involves the use of thin plates and studs held together only by nails. The new method made a large dent in the amount of labor needed at the site.

[3] In 1951-52 a total of $2,880,088,043 was spent by universities, colleges, and other institutions of higher learning for current purposes and expansion of the physical plant. (*Biennial Survey of Education in the United States, 1950-52*, Chap. 4, sect. II, "Statistics of Higher Education: Receipts, Expenditures and Property, 1951-52" [Washington, D. C., 1955], p. 29.)

The use of cast iron in public buildings throughout the nineteenth century, and particularly in the latter part of it, marked a new era in building construction. No longer were builders dependent on masonry or wood for supporting wall, pier, floor, or roof construction. Metal products could not be economically manufactured in an unlimited variety of sizes, so they were produced in a limited number of so-called standard sizes. This development of economical standard sizes together with the difficulty of alteration or cutting metals at the site resulted in a complete change in construction methods. With the development of power tools, economical fabrication of doors, windows, and other wood products—in the factory or woodworking plant—became possible. Off-site fabrication of building materials and structural parts, although far from unknown in the early nineteenth century, assumed in the final decades of the century an importance it had never had before.

In the 1880's and 1890's the rising vogue of employing steel in construction stimulated the use of reinforced concrete, a highly satisfactory building material of considerable plasticity, and susceptible to infinite variations of size and contour. Reinforced concrete proved to be a reasonably economical system of construction, but one that when used with custom built forms still required a high proportion of on-site construction labor.

As metals became more generally accepted, the manufacture of all types of metal building materials and structural parts gained new importance. Window frames, doors, siding, sheathing, and roofing became available in steel, aluminum, galvanized iron, copper, etc. These materials and structural parts were fabricated off-site, sometimes by widely separated manufacturers who could produce stock items at a reasonable cost; when nonstock or special shapes or sizes were required, however, most manufacturers had to make considerable advances in cost. Each producer developed manufacturing methods with paramount regard to economy of production of his own product. Little if any consideration was given to the way his materials, when incorporated in a biulding, fitted to adjacent materials of another kind manufactured by another producer who likewise was giving first consideration to his own manufacturing problems and secondary interest to the problem of fitting his product to other building materials in an economical manner.

During this time certain trade customs were established; they were far from uniform, great variations occuring in different sections of the country, and even in different manufacturing plants of the same producer. These customs became in effect manufacturing standards even though they condoned great variation in sizes and disregarded economy in combining different building products. Bricks were ordinarily 2½″ to 2¾″ high, 3½″ to 4″ wide and 7½″ to 8½″ long, depending on the custom of the particular producer. Wall tile was made in various heights and widths with little attempt to coordinate its sizes with the sizes of the brick with which it was ordinarily used as a facing material. Steel window sash would fit either the brick or the tile, except in those rare instances when they were both born under the same constellation. Structural steel has been manufactured under a formula of structural and manufacturing efficiencies, both necessary requirements but in many instances incompatible with over-all construction economy and efficiency. Mechanical and electrical equipment had generally been produced on a basis of manufacturing and engineering efficiencies with little, if any, consideration for its economical installation at the point of use.

The same was true of nearly all building products manufactured off-site. Because of tradition, custom, and lethargy we fell heirs and became contributors to the chaos which pervaded the building industry; unrelated building materials reasonably priced and efficiently produced were unreasonably costly to install because of the labor and waste incidental to cutting and fitting at the site. While quantity manufacturing has made possible relatively economical production of building materials, the rising cost of on-site labor has in many instances more than absorbed these savings in manufacturing processes. The manufacturers of automobiles, refrigerators, radios, and of countless other items have been able to provide us with a constantly improved product at a price of little more than what we paid twenty years ago. At the same time the building industry has been able to provide a house of somewhat better construction at a disproportionately increased cost.

The success of producing at a reasonable cost a superior automobile, refrigerator, or radio has undoubtedly been due to the fact that these products are made from parts assembled with a minimum of labor. Certainly, if the chassis of an automobile had to be altered to receive the engine, and the body cut off to be fitted to the frame, the cost of the automobile would be greatly increased.

EARLY EFFORTS TO COORDINATE STANDARDIZATION OF BUILDING MATERIALS

The problems of standardization of building materials have been given much thought by many people, but it remained for the late Albert Farwell Bemis to take the first step in bringing order out of the chaotic condition in which the building industry found itself. In connection with his efforts, to which he devoted extensive personal resources, to find ways of improving the housing for lower-income families Mr. Bemis undertook pioneering research on dimensional coordination. He investigated the possibilities of prefabrication and came to the conclusion that the value of prefabrication and on-site assembly methods would be severely limited until the vast assortment of products, which the prefabricator or the general builder must purchase, were made in suitably related sizes permitting the individual pieces of structure to be standardized and simplified for repetitive low-cost production. Mr. Bemis devoted the latter part of his life to extensive research in developing and proving a basis for the dimensional coordination of building products.

After Mr. Bemis's death in 1936 his heirs took steps to preserve and continue his researches. They established, in 1938, a nonprofit organization, the Bemis Foundation, and allocated to its support certain funds available under the will of Albert Farwell Bemis. In April of 1938 Allan Bemis, son of the pioneer researcher, opened negotiations with the American Standards Association on behalf of the Foundation with a view to pooling the resources of the two organizations in furthering standardization and research for modular coordination.

An agreement to initiate such a joint project was reached at a general conference of representatives of the building industry held on September 20, 1938. The Bemis Foundation set up the Modular Service Association to provide technical assistance for the project and transferred to the Association the balance of the Foundation's funds. In November 1938, the ASA Standards Council authorized the project and invited the American Institute of Architects and the Producers' Council, Incorporated to be sponsors. Both accepted in December of that year.[4] In accordance with the usual procedure, and with the assistance of the Modular Service Association, the ASA called in July 1939 the first meeting of the new Sectional Committee to activate "ASA project A62 for the Coordination of Dimensions of Building Materials and Equipment." The Sectional Committee represents all interests of the building industry, including manufacturers, engineers, architects, builders, contractors, consumer groups, and governmental agencies concerned with building.

The Modular Service Association continued to supply technical assistance until 1948 when the funds available from the Bemis Foundation and from other sources were exhausted. After the Association was dissolved other means for carrying on the work of Sectional Committee A62 had to be found. In October 1949 the ASA called a meeting of the Committee, representatives of the sponsors—the American Institute of Architects and the Producers' Council—and representatives of the building industry to determine what steps should be taken to assure the continuation of the project. The meeting appointed a Special Finance Committee which recommended to the sponsors that they assign a member of the Department of Education and Research of the American Institute of Architects as permanent secretary of Sectional Committee A62. The recommendation was accepted and the appointment made accordingly. The arrangement has worked out well and is still in force.

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[4] In 1950 the National Association of Home Builders accepted an invitation to become a joint sponsor.

THE ADOPTION OF THE 4-INCH MODULE

In 1945, an agreement was reached on the establishment and formal adoption of a basic 4″ module as an American Standard unit suitable for dimensional correlation.

The agreement on a 4″ module as the standard basic unit to which all building products were to be correlated marked the beginning of what is hoped will be an entirely new approach to the manufacture and use of building materials. It will become the building block of construction industry.

The adoption of the 4″ module was the result of many years of study of manufacturing processes and consideration of the adaptability of building materials to its dimensions. In the course of the study preceding the recommendation and approval of the module it was found that a basic dimension of less than 4″ is, except in unusual situations, impractical in application to building materials. For example, when it is necessary to extend the width of a 12′ room or space, an increase to 12′ 4″ is a practical minimum increase in size, and except under unusual conditions there would be no necessity or advantage in adding a lesser amount of space. It was also noted from observation of field layout practice that the use of smaller or fractional dimensions causes confusion and mistakes and, as a result, is costly to the builder.

At the same time a dimension greater than 4″ does not allow sufficient flexibility. For example, with the 4″ module the width of windows, doors, or other building features can be 24″, 28″, 32″, 36″, etc., increasing or decreasing in units of 4″ which, again except in unusual situations, permits sufficient flexibility to meet nearly every construction requirement, and at the same time neither involves or violates aesthetic standards nor regiments consumers.

It was also observed that a dimension of 4″ is suitable to the sizes and construction methods used in connection with a great number of building materials. The 2″ x 4″ wood stud spaced on 16″ centers, the 2″ x 8″ and 2″ x 12″ wood joist spaced 12″, 16″, and 20″ on centers, the 4″ wide and 8″ long brick, the 36″ and 48″ wide plywood and wall boards, and many other building materials were already made and installed using a 4″ basic increment of size.

PROBLEMS CONNECTED WITH THE USE OF THE 4-INCH MODULE

The most difficult problems involved in developing standard sizes of building materials were those presented by products which require the use of another material to hold them in place; the unavoidable deviation from an absolute invariable 4″ module was a difficulty that had in the past made impractical the adoption of a standard unit of size of many items generally used in building construction.

This problem, however, was solved by the adoption of a modular dimension which is always 4″ or multiples thereof; in establishing the actual size of the item, however, the necessary tolerance or allowance to accommodate the material required to hold it in place is taken into consideration. For example, bricks are separated by a mortar joint which is normally ⅜″ in thickness. Therefore, the actual length of a brick is from center to center of the mortar joint. If the standard length of the brick is 7⅝″ and the thickness of the mortar joint ⅜″, it is possible to employ a modular dimension of 8″ for the length of a single brick. A similar allowance for construction necessities is made for other materials, but always the final or modular dimension works out to 4″ or multiples thereof in length, height, and depth.

Every building product when being studied to determine how it can be adapted to standardized modular sizes has to be considered in relation to those other materials with which it is generally used or which it adjoins in order to make practical provisions to install and fasten it in place. At the same time the product must be so designed as to permit it to be manufactured economically. This process involves study by producers of materials that will be used adjacent to the particular item that is being standardized on a modular basis. For example, brick to be standardized on a practical modular basis must be amenable to use with standard modular back-up tile, window frames, doors and other building items.

EXTENSION OF THE 4-INCH MODULE INTO USE

To accomplish these technical and detailed studies, the ASA Sectional Committee A62 has set up numerous study subcommittees each giving consideration to a single type of building material or building product; joint meetings, sometimes of several interested or affected subcommittees, resolve the problems involved in standardizing on a modular basis the product under consideration. Concurrently, the manufacturers of building products are being advised and their cooperation solicited in producing their materials on a modular basis.

Since the establishment of the 4″ basic module as an American Standard in 1945, standards have been adopted for brick, tile, concrete masonry units, and flue linings. Other building materials are currently under active study in preparation for standardization.

SAVINGS AS A RESULT OF THE ADOPTION OF THE 4-INCH MODULE

Standardization of building materials on a modular basis will substantially eliminate cutting and fitting at the site. It will no longer be necessary—as it is now—to cart away from the job the tons of cut-off and wasted materials to be transported to the most convenient dump. Waste in both material and labor involved must necessarily be paid for by the owner, and if bricks, windows, doors, etc., can be put in place without cutting of brick, fitting of doors or windows, substantial savings in the cost of both materials and labor are possible.

In addition to these actual savings at the site, the elimination of odd sizes and reduction in the number of stock items carried in the warehouses make possible considerable economies in manufacturing processes and in the cost of storing the materials.

The principle of the standardized building block will undoubtedly make possible substantial savings in manufacturing costs of building products, the saving of many hours of on-site labor, and great savings in materials now wasted. The prediction made at the Research Correlation Conference of the Building Research Institute in 1954 that with standardization of building materials the American people could save up to 20 per cent of the cost of new building is not an unreasonable one.

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10. COMPANY AND NATIONAL STANDARDS IN INTERCHANGEABLE PARTS MANUFACTURE

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STANDARDS are an integral and essential factor in all orderly procedures—social, governmental, industrial, commercial—and all other forms of civilized intercourse between individuals and groups of people. One definition of a standard is as follows:

Standard: That which is set up as a unit of reference; a form, type, example, instance, or combination of conditions accepted as correct and perfect, and hence as a basis of comparison; a criterion established by custom, public opinion, or general consent; a model.

Standards are of many kinds and types and have been developed to varying degrees of refinement. A special form may be created to meet a particular condition. Later, it may be adapted and refined to meet a wider use. Eventually it may be further developed and adopted for universal use in its particular field. Such, in brief, has been the genesis of most of the generally accepted standards of today.

LANGUAGE AND MECHANICAL ASSEMBLY

A typical example is that of the growth of a modern language. Its standardization starts with the compilation of a dictionary to define the spelling and the definitions of the words, which are established by a study of past usage.

Words are only the elements of a language. They must be combined in some order to express thoughts. This requires rules of arrangement, or grammar. In a large country, different sections may develop local idioms and local dialects. Some of these spread over a wide area while many remain local.

New situations and new developments necessitate new words. These may be coined for the specific purpose, or suitable words may be borrowed from other languages. Often such new words or expressions come from the pen of an individual. If they fill a real need, eventually they will be absorbed into the common idiom and become a part of the general standard.

The drawings and specifications used in engineering also form a language which has been developed to convey information about sizes, forms, and structures of engineering projects. A mechanical product is developed, not for itself but for the service it can give. The major effort of a manufacturer is to build a product that will meet the needs or desires of many potential customers.

Using the analogy of language, the design of the assembled mechanism may be considered as the complete essay or text on a particular subject. This mechanism may include several complete subassemblies that perform certain duties. They, in turn, may be considered as chapters or sections of the complete text. The mechanism with its subassemblies is built up from a large number of individual parts or components, which may be considered as paragraphs or phrases. Each component may have many features. A feature is a distinctive and essential characteristic of the component. For example, a machine screw carries the following features: the head which may be of cylindrical or conical form; the slot for the screw driver; the body or stem which is of cylindrical form; and the threaded section of the stem. Each feature may be considered as a word of the phrase. These features must be definitely specified or spelled out, often by notes, dimensions, and tolerances, which may be considered as the alphabet used to spell out the particular word.

Each manufacturing company develops its own dimensional engineering standards as the need arises. The essentials of a standard of this kind are effectiveness, economy, and reduction of variety. Also each company develops, to a large extent, its own method of specifying its dimensions and tolerances. These company standards may be considered as local dialects and idioms, as well as special ways of spelling out the requirements. As long as a single plant only is involved and all parts of its product are made there, this practice may be adequate. The plant may be hampered, however, by its isolation and by not being able to keep in touch with the advance and developments made in other branches of industry.

INTERCHANGEABLE PARTS MANUFACTURE AND MASS PRODUCTION

About a century ago, a revolution in manufacturing practice occurred in this country. This was the successful application of what is called interchangeable parts manufacture. The idea was suggested by a French engineer a few years before the American Revolutionary War. Attempts were made by Eli Whitney and many others to accomplish this in the first fifty years of the nineteenth century, but it took time to develop the improved machinery and special techniques needed to make it a success.

The essence of interchangeable parts manufacture is to make the component parts of a product of sufficient uniformity so that they may be assembled or interchanged without special fitting. In essence, these uniformly made parts of a definite product represented the first attempt to set up dimensional standards for manufacture. Few, if any, dimensioned component drawings were used at the start. The actual components of a functioning and accepted model of the product were used as the standards, and the effort was made to duplicate these model components. This practice was carried on in the manufacture of firearms well into the present century. In 1918 when the government inspector at a firearms plant asked for a complete set of component drawings he received them, but all dimensions were noted as "MODEL."

The use of dimensional standards in manufacturing facilitated breaking down the actual machining operations into a series of elementary tasks. It resulted in a transfer of skill from the mechanic to the machines and the special equipment. No complete part was made by a single person. The skilled mechanics made the machines and tools, set them up, and kept them in adjustment. The actual machining operations could be handled by men who were less skilled. Completed parts were delivered to a finished parts storeroom and issued from there to the assembling department. It should be evident that such a practice required a high order of internal or company standardization.

The manufacturing processes, special equipment, and techniques needed for interchangeable parts manufacture also proved effective for the economical production of large quantities of similar parts. As a result, more and more emphasis has been placed on mass production.

The first cost of the special equipment for mass production is very high. But after the equipment is provided, the unit cost of production is low. As an example, the model room cost of the prototype of a typewriter made by hand by skilled mechanics was about $1200. This included the use of many machine-made parts from an earlier model. After the special equipment was provided and set up, the factory cost of the same product was about $30. The production rate was about 500 a day. There is an appreciable reduction in unit cost with increasing quantities and rates of production.

One important result of this economy of mass production has been the growth of many manufacturing plants concentrating on the production of specialties such as screws, bolts, nuts, rivets; ball, roller, and plain bearings; and many other components and subassemblies which are used in many types of products designed and manufactured by other companies. Whereas the individual manufacturer may use a few hundred of these specialized products a day, the speciality manufacturer will make several thousand a day for his several customers. As a result, the product manufacturer can buy them much cheaper than he can make them for himself. These specialities were first standardized by the respective manufacturers as commercial standards. These were company standards with a much wider usage than ordinary company standards.

TOLERANCES IN INTERCHANGEABLE PARTS MANUFACTURE AND MASS PRODUCTION

Tolerances are essential to interchangeable parts manufacture and to all mass production. Variations in size and form are inevitable in production, and their extent must be controlled for a specific feature. A tolerance is the amount of the variation in the size or form of a given feature that can be accepted. For example, the nominal or design size of a hole may be specified as one-inch diameter. If this is a clearance hole for the body of a bolt, its size may be permitted to vary several thousandths of an inch. On the other hand, if it is a bore for a critical bearing, it cannot be permitted to vary more than a few tenths of a thousandth of an inch.

Within reasonable limits, the wider or more liberal the tolerances, the less expensive the production. A hole with a tolerance of several thousandths of an inch can be produced by a single drilling operation. With a small tolerance it must first be drilled and then reamed in a second operation, or ground if the work piece is hardened. The smaller the tolerance, the more the attention that must be given to the tools and setup. A reamer, for example, will have a very short useful life for the production of a reamed hole with close tolerances. Furthermore, the more exacting the tolerances, the more time and care must be spent in measuring the results of the finished operation. Though normal inspection costs may amount to 5 per cent or less of the machining cost, on extremely close tolerances the inspection costs may run from 50 to 100 per cent.

When parts are made by one manufacturer for the use of another, dimensions and tolerances are an important part of the contract between them. The finished parts are subject to inspection by both parties. When the tolerances are small, there must also be agreement between both manufacturers as to the precise method of measurement that will be used in the inspection. At times, in case of disagreement about the actual measurements, a third party may be called in as a referee. This is usually the Division of Weights and Measures of the National Bureau of Standards. The measuring facilities of both parties may be calibrated there, and the actual parts in dispute may also be measured by the Bureau.

As noted earlier, some tolerances can be very liberal while others must be kept small. Here the functional requirements of the product are the controlling factor. The tolerances should always be as large as the operating conditions of the product permit. On the other hand, for a few important and critical surfaces, any variation at all is a detriment, and here the tolerance must be as small as it is commercially possible to maintain. These small tolerances, however, are the exception and not the rule. Many of them will always remain outside the scope of standardization.

The needless specification of close tolerances is a large and real waste in industry. It is expensive to try to meet them, and no benefit is obtained even when they are met. To quote from a paper by B. H. Blood of Pratt and Whitney Company, on this subject: "Dirt has been defined as matter out of place. What then shall we call accuracy out of place?"

COMPANY AND NATIONAL STANDARDS

As noted before, each interchangeable component entering into the company's products is a company standard. The machining of the features of these components requires many types and sizes of cutting tools. Among the producers of specialities are the small-tool manufacturers. Company or commercial standards for these tools became the progenitors of present national standards in mechanical engineering.

Older designers frequently resent the widening use of these dimensional engineering standards, often contending that their use restricts personal originality. Since most of the dimensional engineering standards are restricted to features of parts, there is actually no restriction of originality in design by their use. In fact, the use of standards eliminates a mass of detail planning and drudgery, and leaves the designer more time to spend on working out the essential mechanism and arrangement of the design.

Regardless of the scope of the standards, they will never meet every need. Exceptional cases will always require special consideration. In the final analysis, the performance of the product itself is the true test of achievement. If an existing standard seems adequate for some feature, it should be tried. If it meets the test of service in the particular application, it should be used. If it does not, some other solution must be found. The performance of the product in service is the final test.

If a standard series of features is to cover a range of sizes, the question arises as to the best difference in size between each successive item of the series. A standard of preferred numbers is available that can be used to establish any such series to cover any desired range. A series, in which each successive item is a fixed percentage larger than the preceding covers any desired range with the minimum variety of sizes.

When there are no existing complications for both national and company standards, size ranges should be set up in accordance with the preferred numbers standard. Unfortunately, in many cases we are tied to the past. Certain types of features were in common use for many years before any attempt was made to collect them into a standard series. As an example, consider standards for twist drills. They developed from different company and commercial drill sizes, and many have been tied to existing wire sizes. As a result, any national standard must be based on existing commercial sizes of twist drills because they are in such widespread use that any attempt to set up an entirely new series would be unacceptable to industry. Any national standard, no matter how great its intrinsic merit, is a waste of effort it it does not meet some real need of industry or trade.

SOURCES OF STANDARDS

Whenever a large amount of detail is to be handled in an orderly fashion, some form of routine is essential. In many respects, the use of company standards is an attempt to reduce to routine as many as possible of the petty details of design, production, and inspection. Material for these company standards is selected from any available source, such as: the company's own experience; industry, commercial, and national standards; catalogues of manufacturers of specialities.

The ways standards developed were many and varied. Some of them, like Topsy, just "growed." Some have sprung from proposals made by individuals. Others developed from company standards that met a wider need. National engineering societies and trade associations have always had a vital interest in standardization. Their work was done on a regional and national scale, but their scope was limited to their own specialized fields.

A few examples might be illuminating. In the early days of ball bearings, each manufacturer made his own races and bought the hardened balls. Companies in this country, England, Sweden, and Germany began manufacturing assembled ball bearings. Each developed its own sizes of races. Service experience demonstrated that the English-made balls were the most durable while the Swedish races stood up best. The outcome was an international standard for ball bearings with the sizes of the balls in inch units and the sizes of the races in metric units.

One of the first technical committees appointed after the organization of the American Society of Mechanical Engineers was given the task of standardizing the Briggs taper pipe thread. Different manufacturers of pipe were using different threads on pipe of the same size, and conditions were chaotic. The standard developed by this committee is now our National Taper Pipe Thread Standard.

After the Chicago fire of 1871, when fire engines from many other cities were sent there to augment the local equipment and none of them could be connected to the fire hydrants because of the differences in the screw threads of the fire hose couplings, the American Water Works Association developed a standard fire hose coupling to meet such situations in the future. Practically nothing was done about adopting the standard by the municipalities, possibly because of human inertia, which George B. Grant, pioneer gear designer, has defined as "the natural reluctance of the average human mind to accept a change, particularly a change for the better." The same conditions as those at the Chicago fire existed at the Boston Fire of 1872, the Baltimore fire of 1904, and the San Francisco fire of 1906. Finally the National Board of Fire Underwriters took a hand in the matter. A sectional committee was organized under the procedure of the American Standards Association in the early 1920's and in due course the standard proposed by the American Water Works Association was approved as the American Standard for Fire Hose Couplings. Any community which adhered to the new standard obtained a lower fire insurance rate, and in a short time the standard was in extensive use. Today its use is mandatory in many of the states of the Union.

The foregoing should give some idea of the variety of applications and souces of mechanical standards.

THE RELATIONSHIP BETWEEN COMPANY AND NATIONAL STANDARDS

The founding of the American Standards Association was the first effort in this country to organize standardization projects on a national scale and to cover all possible fields. The work of this association can be likened to the first compilation of a dictionary to help attain common usage throughout the country.

The concept of absolute uniformity or perfection is not involved in standardization on national scale. An essential part of each dimensional standard is the amount of tolerance or of variation in size or form allowed. With few exceptions, as in the case of safety codes where life or security is at stake, these standards are adopted voluntarily. To gain such acceptance, the standard must be effective, commercially feasible and economical.

Standardization under the procedure of the ASA is carried on through sectional committees composed of persons who are leaders in the design, manufacture, or use, of the item under consideration. No single manufacturing company could afford to hire all these men as consultants to find solutions to small problems of design or production. Hence, when one of the standards developed by them is available, the chances are that it will prove a far better answer than some inspirational solution of an individual engineer.

Since most of the larger companies have their own standards departments the question may be raised as to the relation of company standards to national standards. The national standards are a growing body of practices and procedures accepted throughout the United States. Eventually they will cover almost all branches of industry and trade. A given national standard applies to all commonly used sizes of the item for which it was developed. In effect, it is the dictionary that contains all of the words in common usage. As no single writer will ever use all the words contained in the dictionary, so no single manufacturing company may ever use the full range of sizes covered by a national standard.

The majority of these national standards have been developed from existing standards of all types. They may have been refined and made more explicit, but they are derived from previous usage. Their range may be extended to meet the anticipated needs of a changing and growing demand, but their general form and purpose are based on past experience with the items of the more commonly used sizes.

The company standards, as noted earlier, are selected from any available source, or are formulated specifically to meet the particular needs of an individual company. They will always include many items that may never become national standards, and they will need and include only a limited part of the national standards.

The difference between theory and practice has been defined as follows: "Theory takes care of all known conditions; practice must take care of all existing conditions." This is a good statement of the relation between national and company standards.

Many of the older companies have effective standards for many items which have been used successfully for years before a national standard was adopted. With the introduction of a new national standard for one of these items, the question arises as to its adoption by such a company. Usually the company will accept the new standard for all new designs, but it will retain the older standard for use in connection with the existing designs. The committees developing the national standards recognize the need for a greater or lesser period of time for the transition from the old to the new. The same condition exists to a more limited extent when a material revision of a national standard is made.

Effective standardization on a national scale takes much more time to achieve than is generally appreciated. Some items are under consideration by the sectional committee for ten or more years before an acceptable draft of the first standard is completed. Much of this time may be spent in educating both the sectional committee and the potential users as to the standard's objectives, its limitations, and the methods of bringing it into full usefullness.

A STANDARD SYSTEM OF FITS

In Europe there are elaborate systems of fits for mating parts that are in wide use and have become national standards. In this country we have none as yet, although much thought and work have been given to the subject. In general, there does not appear at present to be any great demand for a standard system of fits on the part of manufacturers and users. In fact, there is definite opposition to it in many quarters.

Among the objections is the fact that, as noted earlier, the performance in service of an assembled machine or mechanism is the acid test of the correctness of its design and the conditions of fit. With many new designs, this needed information is obtained only after extensive experiments and thorough service tests. No standard can ever be adequate to meet every condition that may exist.

As tolerances become smaller, the expense of production increases greatly. With a standard system of fits, too many inexperienced designers will select too close a fit or the one with smallest tolerances in the belief that it is best for the purpose. This is a valid ground for objection because in the case of several existing standards which specify different grades of fit and accuracy, many designers already ask for the most accurate grade, although it is definitely not needed for their particular use. It is only another example of "accuracy out of place."

Reamers for the smaller holes are now commercial standards. To meet the needs of an adequate system of fits, a much closer specification of grades of accuracy of these reamers would be required, and this would increase their cost and reduce their useful life. For economy's sake, the manufacturer should be free to buy standard reamers and to develop his own system of fits so as to employ these tools—new and resharpened—to suit his own needs.

To these objections to the proposal that a standard system of fits be adopted in this country, certain answers can be set forth.

In the first place, neither the proposed standard system of fits nor any other national standard is intended to dictate to a designer or manufacturer what he should do in a specific case. He must find out for himself what he needs. He carries the responsibility for the satisfactory performance of his product. But when he knows what he truly needs, if there is one fit in the standard system that meets his need, he may, by specifying that fit, state clearly, in a way that can be understood by all concerned, exactly what he wants. Here also there will be exceptional cases requiring special consideration. If there is no standard fit available then the designer must specify and use exactly what he needs.

There will always be designers, engineers, and manufacturers who will specify a much higher degree of accuracy than they need, standard or special. The only answer to this is either education of the user or a higher product price that is adequate to meet the expense involved.

As to the reamers and other small tools, the manufacturers of them already must meet the demands for both standard and special items. If an acceptable system of fits can be developed, the present demand for special items will be channeled into the larger demand for a smaller variety of standard items, which should work to the advantage of both the small tool manufacturer and the user.

The number of national standards developed and approved to date and the variety of fields covered by the ASA since its inception are imposing. A study of the list of the existing national standards brings out an amazing picture of the many types of activities in which standardization has become an essential tool. New developments in science and technology are constantly opening up new fields where even more national standards will be needed to exploit them to their greatest advantages for practical and economical use.

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11. THE IMPORTANCE OF COMPANY AND NATIONAL STANDARDS IN PROCESSED FOODS

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VOLUNTARY STANDARDS

THE ADOPTION of standards in the industrial developments of the past century was most influential in shaping the future of business enterprises. Standards can apply narrowly to any one of many facets of a business operation, but in the processed food industry they apply broadly to all facets. The adoption of standards directly affects the use of specifications, measurements, description of finished products, methods and costs of production, and, yes, individual performance, from the raw material preparation to the carrying out of executives' responsibilities.

The use of standards has been criticized in the belief that it eliminates initiative and fosters monotony. This is typical of the thinking of many executives who are sincere in their belief that in resisting the adoption of standards they are protecting their companies against the evils of regimentation. On the other hand, it is widely agreed that the fundamental value of standards in industrial operations is the making of products which give consumer satisfaction and in turn produce increased business. The result is that the use of standards leads to mass consumption through repeat purchases prompted by an assurance of character and quality of goods. Standards further benefit the manufacturer by protecting him from competition with an unscrupulous producer of debased goods.[1]

Absolute uniformity of production within the company to predetermined standards is something for which to strive. Good practical operations, however, require that standards be expressed in terms of tolerances. Also, where standards have been set up, it is vital to clarify objectives and relationships of materials to operations and processes. There is nothing so confusing and frustrating as attempting to develop a process from materials of unknown quality. And, when the standards of a process are determined, it becomes even more important that the materials from which the product is to be made are procured on the basis of known standards. Without this broad use of standards, chaotic conditions will exist regardless of the competence of the organization. Orderly and conscientious use of standards does not restrict individual or organizational abilities. Rather, it enhances them.

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[1] An excellent summary of the industry's divergent points of view regarding standards is given by A. M. Gilbert in his "Food Standardization and Technological Progress," *Food Technology*, Vol. 8, no. 11 (October 1954), pp. 522-26.

The question has often been asked, "Is the development of standards an engineering, purchasing, production, or sales function?" In most industries, standards are generally prepared by the engineering department. This is not true of the food business. This industry was developed by means of applications of engineering, chemistry, and physical sciences. Since chemical and physical specifications are of more importance than those of engineering, the laboratory staff becomes more the directing group in the formulation of standards than the engineering staff. The development of standards is then a coordinated effort of many of the company's departments. In addition to those already mentioned, the purchasing, production, sales, and accounting departments must also participate. We have come to consider specifications which are the basis for standards as the medium which enables the producer, the distributor, and the consumer to speak a common language.

STANDARDS IN PROCUREMENT

Standards have been created for procurement of most ingredients in a successful food operation. Since ingredients may be of a perishable or a nonperishable nature, there must be two approaches to the establishment of these standards. A standard can be prepared from specifications—valid throughout the year—for dry beans, flour, vegetable oils, and products of like nature which can be stored and made available during the nonproducing season. On the other hand, standards for perishable products, such as meats, fresh vegetables, and green vegetables, must be constructed to cover a variety of grades or qualities. The quality of these products will vary with climatic, soil, growing, seasonal, and other factors. If the standards which have been established for the procurement of specific types of perishable products are insisted upon, such products will often be unavailable. It then becomes a matter of whether or not to suspend production of goods requiring the perishable ingredients and, more often than not, temporary adjustments in standards will be made. Good judgment of the personnel responsible for the use of standards is most important and will dictate success or failure of the operation.

PROCEDURES FOR DEVELOPING AND APPLYING STANDARDS

Standards are of interest to food processing companies as an aid to maintaining predetermined quality, and in some instances improving it, simplifying operations, controlling costs, and aiding personnel relationships. They are of importance to the consumer because of the increased purchasing power he gains by making his dollar worth more. Standards are of concern to the government regulatory agencies as an aid in protecting the consumer and assuring him acceptable contamination-free and properly packaged food.

Food industry standards are developed by industry associations, government regulatory agencies, both state and national, and, of more importance, by the food processing companies themselves. The development of standards by trade associations is an attempt by the industry at self-regulation. These standards are frequently of a general nature and deal mostly with the quality of the finished products. National and state government agencies may set up standards for finished food products as an aid in controlling the quality and quantity of foods offered the public. Many times these standards are the result of a coordinated effort of packers and government representatives. Seldom is it necessary for government officials alone to develop mandatory food requirements. The standards growing out of a company's own experiences and requirements are the most influential ones in improving its operations.

In actual practice, company-developed standards represent more than three-fourths of those used effectively in the firm's day-to-day operations. It is a known fact that company relations with suppliers improve at once when orders are based on specifications. The same is true of relations with customers. It is of interest in this connection that Sears, Roebuck and Company has established standards for candies sold in its stores and has recently served notice that within three years it will purchase candy only from makers who have quality control programs.

The H. J. Heinz Company, which uses close to 350 major ingredients and 200 minor ones, has prepared specifications for all items in the major class and is now planning to do the same for those in the minor group. These specifications are based on the standards required for the adopted processes and for the desired quality of finished goods. Copies of the standards are kept in the quality department which prepared the specifications and which carries the responsibility for coordinating its efforts with those of the purchasing and manufacturing departments. Other copies are used by the purchasing department and are included in contracts to specify the material to be furnished. To have harmony throughout the operation, the manufacturing personnel have copies to check the incoming shipments. If the material is found to be outside the desired quality limits and fails to meet the specifications, the goods are rejected by advising the purchasing department, which in turn notifies the supplier of his failure to fill the order as specified. This controlled procurement procedure has eliminated much bickering, has improved the packaging material and ingredients used, and up-graded the uniformity of fill, as well as the average quality of the goods manufactured.

Under the plan of procuring supplies according to adopted standards, tolerances take on higher importance. Sound judgment must be exercised when inspecting receipts and if proper consideration is given to the possible variations to be expected in the material purchased, the successful use of standards will be considerably enhanced.

The H. J. Heinz Company, which packs a great share of its products in glass jars, decided to give much closer inspection to incoming shipments of glass packages—the combinations of glass containers and covers. After many conferences between representatives of the packaging and purchasing departments on the one hand and the sales personnel of several glass jar suppliers on the other, it was agreed to adopt the well-known government acceptance Quality Level which includes specifications for sampling procedures and tolerances for defects, as a basis for the more thorough examination of incoming ware.

This cooperative effort paid handsome dividends in glass package improvement. All types of defects became a part of the standards comprising the specifications for the jars. Major defects were the most critical and, statistically, it took few to support rejection of a delivery. Minor defects were less critical and more of these were accepted before rejecting a shipment. Of the noncritical defects those which mostly affect the appearance and influence production economies were emphasized as most undesirable. This program kept the suppliers much more alert in producing quality glass jars. The inspection at point of delivery led suppliers to install the same type of inspection at their factories.

Thus, the decision to use packages procured with the aid of established standards not only required inspection at the buyer's plant, which led to great improvement in the uniformity of the quality of the jars, but also demanded improved inspection by the jar manufacturer. It was the proper use of tolerances specified in these standards which made them workable. Since it is the policy of the company to maintain several sources of supply and since all suppliers had representatives present when the standards were adopted, it was not difficult for the purchasing department to maintain its usual procurement policy.

PRODUCTION STANDARDS

The use of standards in buying materials and supplies is understood much better by the employees in all areas of a manufacturing operation than the use of standards which apply to production schedules and functions. A filling line may have a standard planned for it. This might include the number of packages produced per minute; the tolerances permitted on the net weights; the number of below-standard packages permitted per hundred produced before closing down the line for repairs; the number of the crew required for smooth operation and the allowable cost per dozen for a successful operation. Before such standards can be adopted, the employees directly affected must be won over to the idea. It is well to give examples and relate other representative experiences. A desire to achieve the results and to better the operation must be aroused in the workers. When the tabulated results become available and a competitive desire created to "beat the bogey," the use of standards in operations will produce favorable results.

We have now outlined the general use of standards in food manufacturing as related to procurement of materials and supplies, procedures in developing and applying these standards, and the in-production-line use of standards. Important as standards are in these areas, they are all supplemental to standards adopted for the establishment of the quality of the finished goods which are representative of the desires, ideals, and principles of the company.

STANDARDS OF QUALITY

To quote one food company president, "Quality and flavor are of primary importance; there can be no production short cuts at their expense. Standards and principles have stimulated our growth and we will never depart from them. We are so proud of our products that we have them all stamped with our own name." It is this sound approach to a food manufacturing business which requires the adoption of standards for all finished products.

The standards for processed foods are very realistic. They are based on experiences, customer opinions and desires, physical limitations of the ingredients used, and the most practical packaging available. They can be separated into:

1. Physical characteristics such as consistency, color, flavor, texture, and general quality.
2. Chemical values such as amounts of protein, carbohydrates, minerals, fats, salt, water, and various other elements depending upon the product being made.

The initial quality standard for a product is the result of the vision, imagination, experience, and general knowledge of ingredients, manufacturing processes, and customer desires of one or several of the executives of the company. This temporary standard is subject to change so long as the change is within the broad scope of the principles adopted for the operation of the business. Any adopted food standard must be elastic within predetermined tolerances based upon the judgment of those entrusted with its application. The variances of the ingredients and the changes experienced in their processing require these tolerances.

Brand Names

The discussion of food standards would not be complete without giving recognition to brand names and grades. While their relative importance is different for different companies, they have an influential place in the customer's mind. In fact, a recent consumer survey disclosed that a surprising volume of foods was purchased by brand names. The standard by which these products are recognized is uniformity. When the buyer likes certain recognizable values and finds that they are repeated in foods packed under a brand name, they become the standards by which she makes her purchases. Many companies place greater emphasis on brand-named finished goods standards than on all the other standards that might be used voluntarily in producing the completed package. Once the brand name is accepted by the purchaser who finds flavor, color, consistency, texture, and general quality of the food gratifying and an acceptable economic value established, the manufacturer should and will protect the name with standards that will often improve the product.

Grades

Nationally known grades have been promulgated by both federal and state governmental agencies. Acceptance of the grades is generally voluntary, but when goods are labeled by grade designation, it is mandatory that they meet the standards of the assigned grades. This semi-official use of standards for packed food products has been of great service to the industry. Some quantity buyers prefer to buy by grade; however, the trend has never developed into a strong demand in the food market. Probably the greatest value of grades lies in that their use enables packers to get credit on warehouse inventories, since loans can be more easily obtained on merchandise of known quality. Much to the surprise of many leaders in the food trade, the customer has not learned to depend upon grade designations in buying her food supplies. Standards for the grades most commonly in use have been prepared in excellent detail and have been used by many manufacturers as a guide in formulating their ideas of brand standards. Perhaps the most disappointing development resulting from the use of grades in processing foods has been the tendency on the part of manufacturers to pack products which will score down to the minimum of the grade. There is a feeling in the food trade that for this reason foods of higher quality will be packed under brand labels.

In recent years, there has developed an industry trend toward offering more detailed information on labels. The argument in favor of so doing is that when the information properly reflects the standards of brand-named products, the buyers will have more confidence in the foods informatively labeled. This, in turn, will aid in establishing more strongly the brand designations. The factual information, usually found on labels and reflecting the standards under which the products were packed, includes quantities by weight, volume or count, color and texture, degree of sweetness or other flavor statements, and estimated number of servings.

STANDARD COSTS

In an increasing number of companies the standards of product quality and production methods described in the preceding paragraphs are formally adopted in operations through the use of standard costs. The "standard cost" in effect is the cost which would be attained if products of the specified standards of quality were manufactured by the specified standard production techniques and in the volume expected. The cost records disclose to top management the so-called "variances" between actual results and the standards adopted. There usually is a beneficial interaction between the attempts to define quality and production standards and standard of cost—one in effect leads to and reinforces the other.

MANDATORY STANDARDS

Left for discussion are the mandatory food standards. Their enforcement is delegated to both the federal and state regulatory agencies. The Food and Drugs Act of 1906 had an exemplary effect on the food industry. It had been recognized for some time, during and after World War I when the food and drug industries made such rapid progress, that the Act was ready for revision. There was a long waiting period until, after much controversy, the Federal Food, Drug, and Cosmetic Act of 1938 became law. There were few peacetime statutes which conferred such broad rule-making authority on a department of the federal government. The law authorized the administrative promulgation of standards of identity, quality, and fill of container for practically all foods.

The conferring of this new power on a federal regulatory agency was received by the food trade with mixed feelings. A "standard of identity" as law could mean that a food product informatively and factually labeled might be outlawed if it did not conform to the standard; it also could mean that ingredients which might be wholesome and beneficial would be forbidden if they were not included in the list of ingredients permitted under the standard. These interpretations, which have stood many a legal battle, at first caused the industry to condemn the standards: it was feared that they were likely to stagnate food processing and research, and generally stifle the progress in the food industry.

The Food and Drug Administration accepted the new law as a congressional mandate. It has been administered by an understanding governmental personnel on the basis recently discussed by Oveta Culp Hobby, then Secretary of Health, Education, and Welfare. She said:

> The Food and Drug Administration and the food industry share the responsibilities and obligations of the administration of the Food, Drug, and Cosmetic Act of 1938. It is not the intention or desire of the Food and Drug Administration to establish "standards of identity" of food products without the complete and full counsel and deliberations of the food industry leaders and the Department personnel entrusted with the operation of the law.[2]

It is true that the customer is buying a service provided by the food manufacturer along with a protected healthful food and this recognition by the Administration has made the food and drug law a workable one.

Under the Federal Food, Drug, and Cosmetic Act of 1938, the Secretary of Health, Education, and Welfare is authorized to promulgate regulations, "fixing and establishing for any food, under its common or usual name so far as practicable, a reasonable definition and standard of identity, a reasonable standard of quality and/or reasonable standards of fill of container," whenever in his judgment such action will promote honesty and fair dealing in the interest of consumers. When the standard for a particular food is established, all packages of this food entering interstate commerce must comply with every detail of the regulations. Such standards are of general application in that all processors must comply with them and all consumers benefit by them.

Officially recognized tolerances of the food standards under the jurisdiction of the Food and Drug Administration are not popular with the food industry but they are a necessity. The tolerances which have been both officially and unofficially recognized by the Food and Drug Administration have become acceptable to the food packer. These tolerances apply to residues of insecticides and fungicides, manufacturing products for which "standards of identity" have been established, and meeting the fixed "standards of fill." The fact that when a standard or some feature of it, appears impractical to the packer the matter can be referred to the Administration for an open hearing eliminates some of the sting of enforced standards. All standards have limitations with respect to accuracy and enforceability. However, such limitations are recognized by those who share in the use and applications of the standards. Without the reasonable use of tolerances and a ready audience of the enforcement personnel, "standards by law" would be untenable for the canner.

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[2] From a speech delivered at the Annual National Canners Association Convention in Atlantic City in 1954.

CONCLUSION

Realistically, the use of food standards is simply an endeavor of industry to manufacture food products of good quality available to the consumer at a reasonable cost. The use of industry standards, as well as those developed by each company, represents an honest desire to better operations as well as to improve the products offered for sale.

The formulation of standards for packed foods which come under the supervision of the Federal Food, Drug, and Cosmetic Act of 1938 is a joint endeavor of industry and government. Each has its own viewpoint, but basically their aims must be the same. These aims are to develop food products that are safe and of value to the consumer. Standards are not necessary to accomplish this, but they are a decided aid in developing a common knowledge and unity of procedure.

Decisions of far-reaching economic impact are made each day in industry and the existence of standards based on facts established by careful research affords an excellent opportunity for industry to capitalize on this accumulated knowledge. Research work on the use of standards is a practical endeavor, and if a standard is found impractical and unworkable it must be discarded. Using a standard in any part of a food manufacturing operation just because it has been issued is not expected. Standards must perform a service whether they are of company origin or the result of federal or state legislation. The growth in the application of standards and specifications to the processed food business attests to their usefulness to the industry.

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12. QUALITY CONTROL STANDARDS

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Scope and Role of Company Quality Standards

BECAUSE standards are concerned with so many phases of a company's operations—purchasing, production, inspection, engineering, finance, research, and sales—their introduction and application within a company are of the utmost importance. For any standards program to be a success, a formal plan should be laid out with careful consideration for the details and the goal to be attained. There is no one best plan, as each company has its own particular problems which must be considered. However, experience dictates that basic rules must be followed if the full benefits of standards are to be reaped.

Of paramount importance are those standards which can be classified as tools for quality control. A recent survey of successful industrial concerns indicated that each had a basic program in which the paramount policy was the maintenance of quality. Since quality is of such primary importance, it becomes necessary to establish a formal group to prepare and maintain written meaningful standards so that a proper evaluation of product quality may be made. As stated above, standards involve so many of the company's operations that it becomes expedient to classify them into various categories which will be of primary concern to specific departments. Irrespective of the type of standard or department involved, the standard must be economically sound, for that is the basis for continued existence in industry.

A formal program that has proved to be successful over a period of years is that in which the standards have been divided into four categories as follows:

1. Purchase Specifications
2. Manufacturing Specifications
3. Finished Product Specifications
4. Test Methods

The author wishes to express his gratitude for the assistance rendered by Messrs. P. B. Proctor and W. M. Rogers in the preparation of the article.

PURCHASE SPECIFICATIONS

The purchase specification is the instrument by which evaluation is made of the purchased raw materials to be used in the production process. It delineates only those physical, chemical, and appearance requirements that are necessary and sometimes enumerates characteristics to be specifically excluded. It indicates the methods of testing to determine compliance with those requirements. With this information set forth the purchase specification enables the purchasing agent to seek the most economical source of supply consistent with the desired quality. It becomes a part of the contract between supplier and customer. To specify requirements which are not essential may lead to procurement of material of a quality higher than necessary and, obviously, more costly.

Whenever possible it is often beneficial for the purchasing department to discuss with the vendor the requirements as set forth in the purchase specification to arrive at a common understanding of the requirements. At such a meeting it has often been found advantageous to have representatives of the quality control and research departments present with their counterparts from the vendor's concern so that there can be a free discussion of the requirements of both companies. These technical men can discuss freely the process requirements on the one hand and the process capabilities on the other, and are able thus to arrive at the most economical and beneficial specification. Such collaboration may result in recommendations for substitutes or alternate materials and lead to savings in cost.

The purchase specification is used not only as a contractual instrument by the purchasing department but as the standard against which all incoming lots of raw materials are tested to determine if the material shall be accepted or rejected.

Incidental to this use of the purchase specification, its code number and name become the nomenclature in formulas, cost calculations, etc., thus tending to prevent errors which might arise if no standard terminology were employed or if proprietary names were used which might vary from lot to lot as the vendor source varies.

MANUFACTURING SPECIFICATIONS

It is not enough to have specifications only for the raw materials used; it is also essential that in production, proper proportions be used, hence the need for other standards or manufacturing specifications. In addition to the formulas, there should be written instructions regarding the operation of the process or equipment itself, where the successful manufacture of the product is dependent on specific limitations.

It might be said that manufacturing specifications are the formal instructions of management to govern methods of manufacture. They contain the formulas and approved methods of manufacture which must be followed at all times, with qualified exceptions covered by "deviation procedures" in cases of emergencies, as will be explained later.

No specification should be so "iron-clad" or inflexible as to prohibit change. Such a policy would cause stagnation and the product would soon become outclassed by competition. Research, development, and plant engineering departments are forever seeking new and improved techniques and processess which must be rapidly and accurately incorporated into the manufacturing specifications.

Such changes, prior to being incorporated into the manufacturing specifications, should be reviewed and approved by all concerned to make sure all are in accord with these proposed changes.

It is therefore necessary for the quality control group, preparing these changes, or revisions, to be kept informed of all proposed developments so that accurate and complete instructions may be incorporated into the specifications to be submitted for approval and passed down the line to the foreman with the least amount of "red-tape."

Manufacturing specifications, more than all others, should be as brief as possible, simple in language, but explicit and to the point and covering all essential details, leaving nothing to question. A manufacturing specification is no better than the ability of the foreman or machine operator to understand the instruction it gives him.

The manufacturing specification in effect protects all concerned; it gives to management the desired product at a determined cost and protects the individual workman from unjust criticism. The workman cannot be blamed for faulty workmanship if he has followed the instructions set forth in a written specification.

Manufacturing specifications are mandatory, particularly in those cases where incentive plans are installed. Without formal written specifications, sight is soon lost of the quality objectives, and there may be a deterioration in quality which will eventually lead to complaints or subsequent high rates of rejection, thus offsetting many of the advantages which would have been gained by the incentive plan. The manufacturing specifications keep the over-all job in proper perspective and should constantly remind the operating men of their instructions and the obligations to be met.

Because of the importance of manufacturing specifications, it is important that all operations be completely covered by such specifications, whether it be for the regular line of product, in-process materials, special customer materials, or products approved on an interim basis.

One innovation that has proved effective in the operation of a manufacturing specifications system has been the institution of a "deviation procedure" which permits some flexibility in the production operations, but at the same time keeps the operation within control. There will be occasions in production when conditions arise which, if the specification were to be followed literally, could only result in the cessation of production or the manufacture of substandard products. Such a situation might arise when a raw material is in short supply but substitute materials are available which, though perhaps deficient in some respects, would permit continued manufacture without a critical lowering in quality. By the deviation procedure, the production department would issue a deviation slip to all regular file holders of manufacturing specifications, informing them that in order to continue operations it will be necessary to make a substitution in raw material, change in formula, or operate the process at variance with the manufacturing instructions. Unless the production department receives specific replies from those responsible for the maintenance of the standards to the effect that the proposed practice is unsatisfactory, production would continue until it was possible to revert to the written standard. Another use of the same deviation procedure is in minor experimental work where runs of short duration are made in order to anticipate the desirability of the proposed changes in full-scale production. Such notification makes for better control of the materials produced and will help in its indentification for subsequent disposal if the material is to be released for field study. It also affords a means of having a permanent record of exactly what was done on such development runs, should this information be necessary in order to complete the study. The deviation procedure affords the production man the means for expressing his initiative and places certain responsibilities on him to exercise his true operating functions rather than shackling him to a strict set of rules. Should the production man's judgment in the opinion of others—the members of the engineering, quality control, or sales department—be leading toward difficulty, they should notify him in writing, warning against continued operation and suggesting other alternatives.

FINISHED PRODUCT SPECIFICATIONS

Once the product has been manufactured in accordance with the purchase and manufacturing specifications, it is then necessary to have a standard against which the finished product can be measured. Finished product specifications then should contain detailed information pertaining to the attributes which the product is to possess. It should have physical and chemical properties and appearance qualifications which, if met, will assure satisfactory performance or functioning of the product in service. These are the objectives of the sales department which have been set on the basis of its knowledge of field requirements. Thus, the finished product specification in effect becomes the written contract between the sales group and production department which states in specific terms what a product is, including packaging, and what its quality shall be with appropriate limits and tolerances. It is only natural that at times the requirements first stipulated by the sales department may not be realistic, since the department may desire a utopian specification which will result in a product in a class above all competition. To adopt such standards would probably not be economical. At the other extreme is the production department's desire for a standard as loose as possible in order to simplify and speed up the manufacturing, and to keep costs to a minimum. Somewhere in between is a balance which is usually the concept of the research or design engineer who has a knowledge of both problems and can put them into proper focus. It then usually falls to the quality control department to review with all three groups the requirements desired by each and to arrive at a mutually satisfactory agreement. This task can often be simplified by the presentation of past data on the same or similar processes which will be a realistic measure of the process capabilities. Thus, the finished products standards reflect a weighing of all the facts.

In many instances, there are governmental and industry specifications which reflect the thinking of many groups, including both producer and customer. Such specifications may run the gamut from idealistic standards, which could not be economically met, to loose standards that reflect the compromises of various groups and are ineffectual. It then becomes necessary for producers' groups to meet and arrive at a common understanding of requirements and present the issuing agency with factual data, indicative of what can be produced and accepted by the general trade. Of necessity, such government specifications are less rigid in their requirements than the standards of some of the individual manufacturers. Conversely, it is often customary for a producer to operate to specifications tighter than the limits specified by the issuing agency to guarantee conformity. In any case, the frank exchange of information both as to requirements and capabilities is mutually beneficial. This has even reached the point where some manufacturers submit their test data with lots of material so that the customers may utilize this test information the better to evaluate the goods they have purchased.

TEST METHODS

To complete the specifications manual, a fourth type of standard is necessary. This fourth section establishes the standards for testing procedures and is often referred to as "test methods." The foregoing types of specifications are of little value unless there is a specific method of evaluating the true quality of the product in terms of the limits given in the other standards. Test results would be valueless if determined under conditions that were irrelevant to the performance of the product. Strength data obtained on a sample in a bone-dry condition might have little meaning if the sample was for a product to be used in a saturated condition. Similarly, test results for strength determined on a machine with a loading speed of 20″ per minute would be different numerically from data determined on a machine with loading speed of 2″ per minute. Even the method of selecting the specimen for test might cause the results to be biased. For example, in those bulk materials which would be quite variable within a single lot, the common method is to take a sample from different locations of the lot and to blend and quarter the sample until a representative mixture is selected for the test. If this were not done, an individual sample would not be representative of the average quality of the lot. Therefore, test methods when written should be very specific with regard to the following points:

1. Method of selecting the specimen for test.
2. Conditioning of sample.
3. Type of test equipment to be used.
4. Techniques of performing test.
5. Method of reporting the test results.

In adopting and writing any test method, it is essential to review all published methods of such groups as ASA, ASTM, federal government agencies, the National Bureau of Standards, SAE, etc., with the object of using a recognized standard which has been proved sound. With regard to raw material specifications, this procedure has the advantage of not imposing on a vendor some new test method peculiar to a prospective buyer which might necessitate special testing and equipment with resultant increased costs.

Revision of Standards

It is important that any specifications system be adaptable to change so that standards may be revised to meet current needs. Specifications should not be static but constantly reviewed to meet the ever-changing conditions imposed on the system. The future always offers better and more economical means of accomplishing the task and industry must gear itself to these changing conditions. In order that the system not fall into a state of chaos, there must be a formal procedure for the revision of all standards in accordance with the desires of top management. The dissemination of the approved changes through the specifications system insures notification to those most vitally concerned.

Statistical Quality Control

Up to this point a successful system of standards and the purpose of the various types of standards have been outlined. There are other aspects of the system that complement the standards which should be mentioned. Foremost of these is the technique known as statistical quality control, which deals with the application of the basic laws of probability to production processes. There are several phases to this approach which are vitally important to any specifications system.

First, the establishment of specification limits based on the statistical analysis of valid data will help insure meaningful standards. A typical example is that of a specification proposed by a customer for an insulating material which the customer had been buying for many years. The purchaser set limits on the proposed specification of 10 to 12 pounds per cubic foot without regard to the quality of material that had been accepted in the past. The manufacturer immediately requested that these limits be broadened to 8 to 14 pounds per cubic foot, triple the original spread. This request was based on a statistical analysis of data from material previously accepted. Increasing the specification limits did not mean that two-thirds of the material would be outside the proposed limits. A statistical analysis indicated that less than 15 per cent would fall outside the proposed limits. Furthermore, the material had been acceptable in the past and experience indicated that to comply 100 per cent with these suggested tolerances would mean costly revision of the processes and thus a marked increase in the cost of the product to the customer. In view of the past satisfactory performance of the material, there was no sound basis for the proposed specification, and the relaxed limits were adopted.

The same approach could be used to set finished product specification limits which reflect process capabilities. If such limits are not acceptable to the sales department, which requests tighter values, it is readily possible to point out that sorting will be required with resultant costly rejections to meet the limits. Also the same approach could be used by vendor and customer in working out a satisfactory purchase specification.

The statistical approach may be applied to a process to control the quality of production and assure that it is within known limits. Data so taken will indicate when the process is operating uniformly and at the desired quality level and also detect changes which could lead to the manufacture of off-specification product. The technique is sensitive to changes in the process and thus becomes a valuable tool for the production man. It is obvious that it is far more economical to save time and material by making the product right the first time, instead of sorting out and reworking items that fail to meet the standards.

Probability techniques have been extended to scientific sampling plans which provide for determination of lot quality from small samples and acceptance or rejection of lots, subject to stated risks of accepting bad lots or rejecting good ones. The need for 100 per cent inspection is thereby eliminated. Here the techniques apply to control within the plant and also to acceptance of raw materials and outgoing shipments. It has been proved repeatedly that scientific statistical sampling can often do a better job, more economically, than conventional methods based on less logically selected samples or on 100 per cent inspection.

It has taken many years for industry to recognize the value of statistical quality control, and it was not until the advent of World War II that the vital need for these methods was realized. This new technique enabled industry to insure the quality of the vast amounts of raw materials being used and also the quality of the finished products.

Industry owes a great debt to Dr. Walter A. Shewhart of Bell Telephone Laboratories for bringing to its attention the basic concepts of the statistical approach to quality control and the benefits to be derived. In recent years the value of these ideas has also been recognized by the technical and other societies. Among these are the American Society of Mechanical Engineers, the American Society for Testing Materials, and the American Standards Association.

During the early part of World War II, the ASA issued the following publications:

Z1.1 *Guide for Quality Control*
Z1.2 *Control Chart Method of Analyzing Data*
Z1.3 *Control Chart Method of Controlling Quality During Production*

Since then, many other publications by the different societies have been issued. One of the most important of these is the *ASTM Manual on Quality Control of Materials.* All of these publications and many books have been utilized by industrial concerns in establishing their quality control programs in order to obtain maximum benefits.

As an indication of the acceptance of the statistical techniques, it is interesting to note that many engineering colleges offer or require courses in statistical quality control, and there are available good textbooks on the subject. With such information available to members of industry, it is only natural that the subject of standards and quality control take on new importance. There is a technical society of approximately 8000 members, the American Society for Quality Control, the purpose of which is to "create, promote and stimulate interest in the advancement and diffusion of knowledge of the science of quality control and of its application to industrial processes." Thus, the standardization of methods utilizing the statistical approach to quality control is being recognized as an important phase of industry's operations and will be receiving more attention as industry continues to progress.

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13. COORDINATING SUPPLY AND PURCHASING THROUGH STANDARD PURCHASE SPECIFICATIONS

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IN A WORK entitled *A Treatise on the Steam Engine* published in 1827, a John Farey described a particular difficulty that plagued James Watt and Matthew Boulton for nearly ten years in their manufacture of the first rotary steam engines. They simply could not buy or build pistons and cylinders that fitted each other.

The borer, Farey explains, "was not guided in its progress, and therefore followed the incorrect form given to the cylinder in casting it . . . ; it was scarcely ensured that every part of the cylinder should be circular; and there was no certainty that the cylinder would be straight. . . ."[1] To make the piston tight in such a cylinder, Watt "wrapped it round with cork, oiled rags, tow, old hat, paper, horse-dung, and other things, but still there were open spaces left, sufficient to let the air in and the steam out."[2] On one occasion Watt measured a cylinder 18″ in diameter and found that at the worst place the long diameter exceeded the short by ⅜″.

Thus at the very birth of the modern industrial age men ran head-on into the basic problem of procuring standard component parts that fitted and worked. The example, of course, is an extreme one; but even in this age of mass production we are not quite so far removed from those early conditions as we may like to think.

As a young man I worked in a railroad locomotive repair shop. We had four different standards for fire hose fittings there, six for other hose fittings, and a generous stock of adapters to make them fit. A ½″ bolt sometimes had 12 threads to the inch, sometimes 13.

Several years later, on starting with my present company, I found that an electric motor with a certain horsepower was built in as many sizes as there were manufacturers. There were many different shaft diameters and heights of motors from base to shaft. We had to have a variety of mounting blocks on hand to bring them into line and a multitude of bushings for the motor pulley bores in order to hold them on the motor shaft.

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[1] John Farey, *A Treatise on the Steam Engine, Historical, Practical, and Descriptive* (London: Longman, Rees, Orme, Brown, and Green, 1827), p. 326.

[2] Samuel Smiles, *Lives of Boulton and Watt* (Philadelphia: J. B. Lippincott and Company, 1865), p. 149.

We had two different tapers in drill press sockets and drill shanks. When we wanted to use a drill of a particular size on the press, we had to select a drill with the same shank taper as the press socket, or else use an adapter. We skinned our knuckles using adjustable wrenches on nonstandard nuts and bolt heads. Engine manufacturers used to supply wrenches with their machines; otherwise we had only open-ended wrenches for use on special machinery.

The moral, which is fairly obvious, is that the manufacturer must be able to rely on uniform quality of the raw material he uses and of the parts he buys for assembly. His customer in turn must be able to rely on uniform quality and performance of the manufacturer's goods. If the manufacturer could not so rely on uniform quality and performance, he would be forced to change his operations constantly, and his manufacturing costs would be greatly increased.

PROFIT BUYING

In order to obtain the required uniform quality and performance, the manufacturer must buy his materials and produce his goods according to accurate specifications. To withstand competition, he must have an assured supply of material of the proper quality and at the proper price.

A survey for 1953 shows that the hundred largest manufacturing companies in the United States had a total income of more than $91 billion and spent 52.4 per cent of this amount on goods and services purchased from others. This is about 8.5 times as much as the average profit earned by these companies. This indicates that there are probably as great possibilities of making savings in purchasing as in other operations of a company and that dollars saved in purchasing are profit dollars. It can probably be assumed that the percentage is approximately the same for the hundred smallest companies, and that purchasing profits are even more important in small organizations than in large ones.

Profit buying means quality buying. Quality buying is the buying of goods of a grade that will fulfill the requirements for which they are intended. They should neither fall short of these requirements nor exceed them. In some instances the primary consideration is durability, and the question of immediate cost is secondary to long life. In other cases the life of the item is not so important, while efficiency in operation is the most significant factor. When specifications call for material and goods which fall short of requirements, they may increase production costs through breakdowns, repairs, idle time, and frequent replacements. Where specifications call for better quality or closer tolerances than are really needed, production costs are increased unnecessarily, and the manufactured goods may become uncompetitive.

Profit buying requires specifications describing the goods needed. The specifications should be as simple as is consistent with accuracy. They should be clear as to methods of checking and reasonable in accepted variations and tolerances. They should be fair in all details to both buyer and seller, and permit maximum completion.

Before an ideal specification can be developed, many factors must be considered and each given its proper weight. In many cases it is necessary to know the methods of manufacturing the product as well as the function which the product is to fulfill in use. Rarely can a single individual combine all knowledge and experience necessary to write a specification that will describe accurately all the required properties of the product and allow its manufacture at the lowest possible price. Therefore, good specifications usually result from the cooperation of a number of experts.

One of the first activities of trade associations, when organized, was frequently to draw up specifications for the goods produced by their members. These industry specifications placed all members on an equal competitive basis. The specifications, while drawn up by manufacturers, usually considered also the requirements of their customers. If they did not, they eventually had to. When the manufacturers did not meet such requirements, the industries that bought the products soon developed their own specifications.

Purchasing officials have always recognized the advantages of standardization, even when they were simply following their own company standards or were buying materials, supplies, and equipment by brand names rather than by objective standards. Since World War II their interest in standards has increased markedly. There is widespread consensus among today's purchasing men that a national standard, if it meets the particular needs, gives the greatest value. It is generally accepted by both the company's suppliers and its customers. It is regularly reviewed and brought up to date. It has already eliminated duplication and conflict with other standards in the same area.

SCIENCE OF PURCHASING

Modern purchasing is not just order placing. To determine the most profitable purchase, it is necessary to study carefully the requirements, what the market offers, and future possibilities. In some organizations a continuous study of these factors is being carried on under the name of "purchasing research." In others, it is known as "value analysis."

No matter what its name, the goal is the same—a specification that will result in "the one best buy for the intended purpose."

Stuart F. Heinritz, editor of the magazine *Purchasing*, put it this way at the Firth National Conference on Standards:

> One of the recent developments that looms large in all modern thinking and practice in the field of scientific purchasing is the . . . process of engineering unnecessary costs out of the products that are bought. The old method of seeking cost reduction in purchasing was through price negotiation that rarely got down to the basic costs of materials and fabrication. Those elements of the supplier's cost were regarded as the solid, impenetrable—even untouchable—price base. The new method goes deeper. It goes right down to these direct cost factors. . . . The negotiation is concerned primarily with the design and construction of the item to be purchased.

REVISION OF STANDARDS

In a great many cases it has been found that a company standard, perhaps good when adopted, is now obsolete, and that a national standard will provide better goods at a lower price.

When one company reviewed its stores inventory and checked the specifications covering each item carried, it was discovered that all cold rolled steel round sections were specified "to be turned and ground to size." Investigation disclosed that this specification was necessary years ago when most of the round cold rolled steel was used for line shafting. The cold rolling produced a skin stress in the rod and the shaft would bend where this stress was relieved by cutting a keyway. Shafting which had been turned and ground had no locked-in stresses and remained straight after cutting keyways anywhere in its length. It had been many years since this company had discarded all line shafting and it no longer required any of its shafting to be turned and ground, but an extra price had been paid on every pound purchased because the standard had not been kept up to date.

Many purchasing departments have been printing their own standards. Some are exact copies of recognized industry or national standards, but too often no procedure is set up for their review.

Today's high break-even point and the growing need for the elimination of all waste has brought about an increased use of company store catalogs and a tightening of inventory control. The store catalog requires a clear, concise, and consistent description of each item stocked. Many items can be fully described by reference. For example, square head black steel bolt ½″ x 4″ with nut, needs no further description thanks to the fact that it is made according to nationally recognized standards. Other items may require more details, and some may need a company standard specification. A standard of a recognized engineering society, of ASTM or of ASA, is much to be preferred because the established procedures of these organizations call for review and revision of standards when necessary. For this reason, the use of such standards by reference will assure the purchasing agent that his specification will remain up to date without action on his part.

STOCK CATALOG AND PURCHASE SPECIFICATIONS

The use of a stock catalog, when accepted by purchasing, engineering, operating, and stores departments, results in a standardization that coordinates the decisions of all departments in the company. The analysis of the products and materials necessary to the establishment of a stock catalog and the resultant simplification may also lead to the following advantages:

1. Lower inventory, with fewer sizes and more interchangeability of parts.
2. Lower purchase prices resulting from quantity buying on fewer sizes.
3. Better workmanship.
4. Easier inspection.
5. Simplification of service and maintenance.

The company that has drawn up an adequate stock catalog already has the basic information needed for approaching the problem of establishing purchase specifications. Purchase specifications are more complex and go considerably further than does the stock catalog.

The purposes of a specification are, first, to establish better communication between all those concerned with the manufacture of an item, and second, to provide an exact and clear description of the item and its required properties. The selection and arrangement of the words of a specification are important. The writing of a specification is a practical job and not an inspirational one. It is engineering, not literary, work. Words should be short, in common use, and not subject to misinterpretation. The specification should describe exactly what is wanted and nothing more. It should be phrased in such a way that

—it permits competition among vendors;

—it covers material good enough, but not too good, for the services intended;

—it can be satisfied by the standard merchandise;

—its tolerances are reasonable;

—it is clear and simple;

—it is complete;

—it is fair to the vendor;

—it can be checked and includes a description of the method of checking.

To insure the best results it is advisable to ask several suppliers to check a new specification and to get their advice. Such procedure sometimes results in lower costs with no sacrifice of quality. In any case, cooperation with the supplier in adapting standards is likely to result in benefit to both parties. One of the great advantages of an American Standard is that the procedure used in producing and approving the standard gives a voice to the manufacturer, dealer, user, and anyone else having a substantial interest in the standard.

The literature on standards is filled with examples of savings in dollars, time, and materials resulting from maker-user cooperation in standards. One striking example cited by E. H. Weaver of Union Oil Company, California, goes beyond that and shows how a company acted to benefit both its competitors and the buying public by adopting a standard.

Union Oil used to buy a specially designed type of underground gasoline tank for service stations. Every purchase it made of these tanks was considered a special assignment for the supplier. The company could buy in quantity, but that involved storage and money tied up in inventory, both of which added to operating expenses.

A Union Oil official investigated and found out that the same situation applied to each of the major petroleum marketing companies on the West Coast. He called together the petroleum companies and the tank manufacturers and explained the problem. After several meetings, all the parties agreed on a common standard for underground storage tanks.

The standard quickly benefited both groups involved. The petroleum companies were benefited because, for the first time, they were able to buy the tanks on an off-the-shelf basis. There was no storage problem and there were no funds tied up in inventory. The manufacturer, on the other hand, no longer had to keep an inventory of special-size steel sheets to meet the different specifications of each company. Since the standard tank sizes were based on the standard sizes of mill-rolled sheets, the amount of waste was reduced or eliminated completely.

That example could be followed even further—back to the mill, to the parts supplier. All those involved probably derived some advantage from the new standard, both in actual savings and in improvement of their competitive positions. The example could also be carried forward to show a saving to the ultimate consumer.

One of the most notable facts that inevitably arise from all of the technical analyses of the value of standards is that the benefits and savings spread themselves through the whole economy. Elimination of waste, smoother production flow, simplified storage and distribution, reduction in unnecessary sizes and types—all these are beneficial to user as well as to producer, to buyer as well as to seller.

Modern business requires modern standards. They are vital for the survival of each individual company. In the words of a tractor company slogan of some years ago, "You can't do today's work with yesterday's equipment, if you expect to be in business tomorrow."

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14. AMERICAN STANDARDS IN COMPLEMENTARY INDUSTRIES

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EARLY PHOTOGRAPHIC STANDARDS

The various photographic interests in the United States, working through the facilities of the American Standards Association, have developed nearly 300 national standards since 1931. This was the accomplishment of a united effort by producers, large and small, of photographic materials and equipment, along with consumers, distributors, and associated organizations of many types. Photography, in scarcely a hundred years' time, had developed from an interesting experiment to an industry of eminence in the American economy, with other industries either wholly or substantially dependent on photography for their existence. This development had come about without the benefit of industry-wide or national standards, for the photographic industry, prior to 1950, had no trade association. The organization and growth of one large company and several smaller ones had taken place in an atmosphere of intense competition with no tradition of mutuality and no cooperative attempts to solve industry problems on an industry-wide basis.

The first American Standards for photography were a group of fifteen for motion pictures. These standards had to do with the dimensions of film, and the sound and picture records placed upon that film. These standards were a self-evident engineering answer to the problem of producing, duplicating, and exhibiting motion pictures of uniform quality in many localities around the world by means of equipment of various designs.

This pioneering activity in developing photographic standards for motion pictures brought into the purview of photographic standardization not only the manufacturers of sensitized film but many of mechanical engineering and fabricating firms—within and without the photographic industry—which build cameras, projectors, film processing machines, storage cabinets, sprockets, reels, film perforators, and many other adjuncts of the motion picture. Also involved was the electrical industry with set illumination equipment, projection light sources, and, more recently, the electronics branch with sound recording and reproducing devices, photoelectric exposure meters, and finally the motion picture aspects of television. The optical industry also was concerned with cinematography in various ways as was the chemical and dye industry and a host of specialty manufacturers whose products had to be tailored to the special requirements of motion pictures and of the sensitized photographic film on which the motion picture depends.

In 1934 an international dispute involving the interpretation of an American Standard for nontheatrical motion picture film broadened the scope of photographic standardization activity in America. The photographic industry in the United States, deeply involved in the dispute, decided to participate in the development of international standards for cinematography and also to look into the matter of both national and international standards in photography in general.

The effectiveness of that international episode in stimulating the development of American Standards for motion pictures is attested by the fact that by 1955 there were no less than eighty national standards for motion pictures listed by the ASA. A great many of these standards naturally had to do with the dimensions of film and the picture images and sound records impressed upon that film. Others dealt with dimensions of reels, cores, and film handling equipment of various types. In addition there were some twenty standards dealing with test methods. Others dealt with standard practices and with specifications for such things as screen brightness, sound transmission of projection screens, the calibration of projection lenses and the characteristics of "release prints," the name given to films in the final form used by theaters.

On February 21, 1939, Sectional Committee Z38 on Photography was organized by the ASA to deal with fundamentals of the photographic process and with all aspects of still photography. Nearly twelve years later, on November 30, 1950, that committee, having developed more than 180 American Standards, was reorganized into four separate Sectional Committees under ASA procedures.

The first of these Committees, PH1, dealing with the physical and chemical characteristics of films, plates, and papers, has developed a group of dimensional standards for sensitized goods. Other standards deal with dimensions of film accessories such as spools, packs, magazines. Still others specify the characteristics of "safety" (low fire hazard) films and films used for "permanent" records.

The Sectional Committee on sensitometry, PH2, has established an internationally recognized method for rating the sensitivity of films used for black-and-white photography outdoors. It also is responsible for standards for fundamental photographic concepts such as spectral sensitivity indexes for photographic films, and a specification for diffuse transmission density. The characteristics of photoelectric exposure meters, the photographic efficiency of illuminants, methods for the sensitometry of photographic papers, also are dealt with by this committee.

Characteristics of cameras, printers, projectors, viewers, and numerous items of accessory equipment are the concern of the Sectional Committee on Photographic Apparatus, PH3. A fourth Sectional Committee on Photographic Processing, PH4, has established specifications for photographic grade chemicals, covering more than fifty chemical substances. This Committee also developed standard practices for the temperature of processing solutions, for the accuracy of scales (thermometers, graduates, weighing devices) used in photographic processing, and standard methods for determining the melting point of emulsions, and the residual harmful chemical content of processed photographs. Dimensional standards for processing tanks and film hangers used in those tanks, the specifications for photographic trays, print glossing surfaces, and similar equipment used in processing photographs have evolved from this committee's activity.

Prior to the organization in 1939 of Sectional Committee Z38 to deal with standards in the entire field of photography, the industry had felt the growing need for national and international standards. In consultation with the ASA, an industry committee surveyed the entire field of photography and developed a master chart of all the aspects of photography that appeared to be subject to standardization. This plan served as guide for the organization of subcommittees of Z38 which were in many respects similar to the Sectional Committees PH1, PH2, PH3, and PH4 mentioned above. It also served to bring into focus the meaning of the term "the field of photography" and to define that term in a broad manner as it related to the scope approved by the ASA for the new photographic standards committee. That scope provided for "the formulation of definitions, dimensional standards, and recommended practices in the field of photography, and the establishment of methods for testing, rating, and classifying the performance characteristics of materials and devices used in photography, including its industrial applications, but excluding cinematography."

THE FIELD OF PHOTOGRAPHY

Expansion of the photographic standards program beyond the specialized field of motion pictures brought many more industries into the picture. Paper manufacturing for the exacting requirements of photographic raw stock and the packaging of sensitized photographic materials was one of these. Others were the plastics industry, manufacturing of noncorrosive metals, and the X-ray industry in both its medical and industrial aspects. A host of additional specialty manufacturers became involved one way or another in the problems of photographic standardization and the new science of nucleonics also discovered its intimate relationships with photographic technology.

Manufacturers of commodities that are purchased by the photographic industry had, during the years, been schooled in the special requirements of photography. In some cases the commodities in question go into photographic materials as product components. They might also be materials used in the construction of manufacturing and processing equipment. It is probably a fact with few exceptions, particularly in the case of sensitized goods, that nothing is purchased by photographic manufacturers that is not also manufactured somewhere within the photographic industry itself. This circumstance arises from the critical nature of photographic materials and their natural sensitivity not only to traces of light but also to other influences such as pressure, heat, moisture, chemical reaction, and invisible radiation.

Expansion of photography as an art and the multiplication of its applications in many fields of human activity have brought new enterprises into the circle of photographic manufacturers. Some of them are individual, independent companies the products of which are exclusively photographic, such as electronic flash equipment and photographic processing equipment. Others, like the factories making photographic flash lamps of the non-repeatable type, are adjuncts of the electrical industry; in some cases, though, their products are exclusively photographic in conception and use. Still others lie entirely outside the photographic industry but fabricate photographic components on a price and service basis according to rigid specifications provided by firms within the photographic industry. Plastic molders, metal fabricators, producers of adhesives and surface finishes may be found in this group.

In setting up an American Standards project for standards in photography it was necessary to consider all these various types of business and their relationship to photographic standardization. The scope of the project and the interest of producers were eventually established by defining the field of photography.

The field of photography was defined for American Standards purposes to include all materials that are sensitive to radiant energy and the processes, equipment, and materials involved in the production and use of photographs. Some objections have been raised to the breadth of this scope, mostly from within the photographic industry itself. The accomplishments in the form of national standards approved by the ASA, and the manifest dollar savings to the industry and to the consumers that have resulted from national standards for photography, have provided an effective answer to those objections.

All this was not accomplished without conflict. The effort and interest of many people in many enterprises, some with widely differing relationships to the field of photography, was needed. Bringing together people of diverse interests and backgrounds produced the expected interferences that called for adjustment. The patient devotion of forward-looking men was required to overcome old prejudices, to replace competitive attitudes with cooperative attitudes, and to get people who, in some cases, formerly pretended to ignore one another's existence to sit down together and work out agreements for the good of all concerned.

THE TRADITION OF SECRECY

The photographic industry, as a segment of the chemical industry, has inherited a tradition of secrecy. Just as the shadow of the medieval alchemist hangs over the laboratory of the chemical scientist today, so does the photographic process itself retain the aura of mystery and magic with which it came to the attention of an astonished public scarcely one hundred years ago.

All of the trappings of photography in its infancy added to the panoply of mystery. The garret atelier with its strange skylight; the black box which was the camera itself; the disappearance of the photographer under a black focusing cloth from which he, unseen, could observe every move of the sitter; the rushing in and out of darkrooms where only the photographer or his assistant might enter; the sight of bottles and the smell of unfamiliar chemicals; the photograph itself, capturing an instant of life and fixing it eternally on a piece of paper—all of these contributed to the tingling secrecy of photography.

Starting as an art, photography has only lately succeeded, and incompletely here and there, in its struggle to become a science. The fact of photography has always preceded the theory, the latter invented afterwards to explain the former. The pioneers in photography dealing with those means and materials which, in their hands, produced successful photographs, jealously guarded the secrets of their trade. The early photographer was his own manufacturer, by necessity, for photography started as an individual laboratory process. When individual photographers began to concentrate more on manufacturing for others than on making photographs themselves, they took with them into the manufacturing process the traditions of secrecy that had imbued the individual worker in photography.

A WORKING PHILOSOPHY FOR STANDARDS

Perhaps the most remarkable feature of ASA Sectional Committee Z38 at its earliest meetings was the speedy evaporation of attitudes of suspicion, distrust, self-protection, commercial advantage, and *caveat emptor.* When the representatives of many industries possessing a common concern with photographic standards met together to set moving a national standards project in the field of photography there emerged, almost at the outset, a philosophy to which all the interests, large and small, wholeheartedly subscribed. This philosophy, which continues to keynote the photographic standards program in the ASA, was fostered and developed by two men, who have since departed. One was Dr. Paul G. Agnew, Secretary of the ASA, who patiently over the years sought to interest photographic manufacturers in the benefits of voluntary national standards. To him belongs the credit for initiating the photographic standards program in America. The other source of inspiration and guidance was Dr. Loyd A. Jones of the Eastman Kodak Company Research Laboratories. He served more than a decade as Chairman of Sectional Committee Z38 from its inception until it was reorganized as four separate committees. During all that time Dr. Jones placed the interests of national standards above commercial interests of any sort and, more than any other individual, helped to develop the ruling philosophy of the group. That philosophy has often been summed up in the words: "If it is good for photography, it is good for everyone in photography."

Until the American Standards project got under way and began to achieve results, some companies had not realized that they were "in photography." Others, on the contrary, realized they were not in but ought to be, and did not know how to get in. Manufacturers of common chemicals such as sodium carbonate, sodium sulfite, potassium bromide, ammonium thiosulfate, and a number of other simple compounds that are used in large quantities for photography had been troubled for years by rejections. Photographic concerns tested batch samples from these manufacturers for suitability either for compounding processing formulas or for use in photographic layers, and rejected them as unsatisfactory. There was little explanation for the rejections. The old tendencies to secrecy played a part. So did the fact that, among photographic manufacturers themselves, some of the tests were empirical. What made such rejections even more baffling was the fact that sometimes chemicals which qualified as U. S. Pharmacopeia grade—or even for Reagent Grade —were rejected for photographic use.

American Standards for photographic grade chemicals changed all this. Chemists from different companies pooled their knowledge and experience. They found that their individual problems were industry problems and susceptible to a common solution. They did together what none of them had been able to do separately. A set of specifications and methods of analysis was developed for the principal chemicals used in photography. By 1955 about sixty of these standards were in the hands of the chemical industry. The chemicals manufacturers, equipped with these standards, could produce compounds to specification and offer them to the photographic trade with the assurance that their products would be found acceptable. The photographic concerns themselves have found that the American Standards for photographic grade chemicals save them money every day. These savings accrue in the elimination of a large volume of acceptance testing, in the speeding up of the procurement of raw materials, in the lessening of rejections and returns, and in the possibility of reducing inventory stock-piles.

EFFECTS OF GOVERNMENTAL PURCHASING

Procurement methods of the U. S. Government have had profound effects on the initiation and development of national standards in the field of photography. Some American Standards for photography have been developed by the photographic committees at the request, direct or indirect, of some department of the federal government. Indirect requests sometimes have taken the form of technical activity to produce an American Standard that was initiated and stimulated by fumbling attempts of specification writers who lacked the knowledge of the subject, training in technology, and the resources available to the standards drafting committee. Individuals in some government departments, on the other hand, have made important technical contributions to American Standards for photography, particularly in the case of test methods. The photographic standards committees have always enjoyed the interested and effective cooperation of clear-thinking people in the various government departments.

A series of American War Standards for photography was developed under ASA auspices for the armed forces by a War Emergency Standards Committee Z52 from 1943 to 1945. These war standards, along with some of the unfinished projects worked on but not completed by Committee Z52, were later brought into form and approved as regular peacetime American Standards. The Committee brought into active participation in standards drafting activity many war contractors and subcontractors who had had no previous knowledge of the special requirements inherent in photographic materials and apparatus. Through that participation a great deal of valuable technical information vital to the design and production of photographic instruments and equipment of satisfactory quality for military use was exchanged. Knowledge of specialized photographic requirements was quickly and willingly made available through this standards activity for national defense to firms which needed it in order to produce, without prior experience, photographic material suitable for military use.

Occasionally a department of the federal government purchases, from sources outside the photographic industry, photographic materials or accessories that are offered at a low price under competitive bidding. Subsequently it is discovered that the material or accessories cannot be used with existing processes or equipment. The product may have been designed by an enterprising vendor to comply with a loosely written specification. Such contractors, long on legality but short on morals, apparently feel no responsibility whatever for supplying something the government department can actually use.

Many American Standards in photography have been developed as the result of such instances when representatives of federal agencies have asked a photographic committee, or the ASA itself, to come to their aid.

One such request received in 1954 from one of the units of the Department of Defense sought the development of an American Standard specification governing the dimensions of dark slides. Dark slides are sheets of opaque material used in sheet film holders to protect the film within them from light until the holder is in position for picture-taking in the camera.

The dimensions of sheet film holders have for many years been specified by an American Standard which guarantees that they will accept and retain sheet films of standard dimensions and that they will properly fit the backs of standard view cameras without leaking light. The details of the dark slides had always been considered a design feature rather than a functional detail subject to standardization. Each manufacturer is required, for quality reasons and the satisfaction of his customers, to provide dark slides that will function properly in holders of his manufacture.

Concerns which sell to the government, however, do not have to provide the quality any customer has a right to expect. All they have to do is satisfy a purchase specification which may or may not insure the purchase of a satisfactory commodity. The government department in question ordered dark slides without specifying that they were to fit the particular style of sheet film holders in which they were to be used. The department simply ordered dark slides of a certain size—perhaps 4″ x 5″—and received some dark slides of that size that could not possibly be used safely in the holders for which they had hopefully been procured.

In other instances the government, by setting up too rigid purchase specifications, has continued to buy outmoded products when superior ones could be obtained at lower cost. An example was the specifying of prepared developers for photographic films and papers compounded according to formulas that had been published in the trade for more than fifty years. All of the important photographic film and paper manufacturers in the United States had meanwhile stopped producing preparations of these old-fashioned formulas. The old-fashioned developers could be furnished only at high cost for manufacture because of short runs on special orders, lack of preprinted packages, and other expensive concomitants of low-volume production.

The leading manufacturers of photographic chemical preparations declined to bid on the outmoded developer formulas because of the nonstandard nature and prohibitive cost of resuming special production of small orders. These manufacturers had replaced such products in their regular lines by various proprietary film and paper developer preparations that were superior in photographic quality, in useful life, and in keeping quality. The newer and better preparations could not satisfactorily be described in governmental specifications simply by listing their ingredients. This was true not because the ingredients were trade secrets (analytical chemistry could have disposed of that obstacle in short order) but because the proprietary formulas contained patented materials; consequently specifications mentioning them would give the patent owner an undue advantage. These newer additives were in large measure responsible for the superior performance of the proprietary products.

The result was that ubiquitous enterprisers, offered an invitation to bid and a formula specification, could go into the photographic chemical business. They found it easy to learn the market price of bulk chemicals—very likely of "technical grade" materials rather than "photographic grade"—then calculate the cost of containers, labels, and labor, and make their proposal. If they received the award, a good deal of grief inevitably resulted. Some of the facts of photographic chemistry had to be speedily learned the painful way: proper mesh size of crystals, moisture content of deliquescent crystals, mixing techniques such as grinding two chemicals together to provide a homogeneous mix for proper metering and filling, techniques for avoiding the caking of chemicals during storage, even the source of supply for some chemicals which are used only in photography and not generally listed in catalogs of bulk chemicals.

Here again the photographic standards program has come to the aid of government agencies which must obtain supplies by competitive bidding according to Purchase Specifications. A committee started work in 1953 on American Standard performance requirements for photographic developers of various types that can be cited directly in Governmental Purchase Specifications, avoiding the hazards of listing a processing formula.

When an American Standard can be cited in the invitation to bid and the purchase specification of a government department, everyone profits. These American Standards are especially useful to the agency which, at no expense to the government, obtains a technical document prepared by the best informed photographic talent in the country, approved by all segments of the American photographic industry and by the consuming public as well. Such standards, being immediately useful for technical citation in a purchase specification, enable firms outside the photographic industry to learn, authoritatively, the technical requirements for photographic goods used by the government departments. They serve to protect the U. S. Government against the purchase of unsatisfactory or unusable materials supplied by contractors who are unacquainted with the requirements of photographic processes and photographic equipment.

Many departments of the government recognize and appreciate the value of the technical resources placed at their disposal in the highly technical field of photography by the photographic standards program. Some departments have participated in the technical work of the standards committees and have made important contributions to that work. Others have made use of American Standards for photography and cinematography without assisting directly in the formulation of the standards. It has been heartening to the photographic committee members to note a growing appreciation by government purchase specification writers of the great utility and sound value of American Standards as reference documents.

HOW THE INDUSTRY PROFITS FROM STANDARDS

The development, use, and evaluation of photographic standards has produced enormous changes in the attitude of management toward national and international standards. An executive of a large photographic concern was quoted in 1942 as stating that one meeting of a standards committee (dealing with the question of still picture dimensions on 16-mm. cine film) had saved his company more than the total cost to his company of all ASA standards activity during the previous twelve years.

This represented an entirely different attitude from that expressed by another executive of the same company in 1938 who said: "We don't need any American Standards. The way our company does things is standard. We don't care what other people do."

Industrial engineers in another photographic concern calculated that one standard (specifying minimum dimensions for amateur roll films), by reducing the waste of sensitized film, saved the company every year more than the traveling expenses and salaries chargeable to ASA activities of all the officers and employees of the company working on American Standards projects.

Sales managers, who sometimes are indifferent to standards for photographic products—when not outright antipathetic—have shown a change of attitude too. Some traces still remain in the field of photography, and allied fields such as radiography, of the old, shortsighted policy of providing units that are not interchangeable with competitive units, in order to tie up additions and future replacement sales. The prevalent idea, however, is that interchangeability—brought about and made possible by international standards—is a good thing.

The reduction of the number of items that have to be manufactured and carried in stock—brought about by the use of American Standards—has gradually come to be regarded as an asset by sales organizations. Service has been improved by having fewer items and keeping them in stock. The sales departments have found their customer relations strengthened and improved because in cases of disputes concerning sizes of materials it was possible to refer to a national standard. Even the dimensions of nonstock or nonstandard items have been specified in advance by provisions in American Standards establishing tolerances for new sizes of photographic sheet films and papers.

Manufacturers outside the photographic industry have found it easier and more profitable to sell to photographic manufacturers through the use of American Standards. This is true of chemicals manufacturers, as noted above, and it is also true of manufacturers of other commodities having "photographic grade" specifications recognized by the ASA. Concerns planning to enter into the manufacture of photographic accessories and apparatus have found in American Standards the guidance they need (wholly unavailable to them elsewhere on an organized basis) in order to manufacture products that will perform satisfactorily.

The growing international commerce in photographic materials and apparatus has increased the need for international standards. In some countries national standards for photography have a longer history than in the United States, but no other country, at least up to the present, had covered the subject so thoroughly. This accomplishment of the photographic industry in the United States, achieved through the ASA, has had both a stimulating and a guiding effect on international standards activity.

In some foreign countries, just as in the United States, there are a few concerns which have not yet realized the benefits of national and international standards and the mutual agreements which standards exemplify. An example is the German firm which, late in 1954, declared (with respect to nonstandard camera accessories), "We don't follow standards, we make them." However, such attitudes are disappearing in the international market just as they are vanishing in America as management becomes conscious of the logic and wisdom and the monetary profit that is inherent in the establishment and use of standards.

STANDARDS AND THE PHOTOGRAPHIC CONSUMER

The guiding principle of the photographic standards committees, "If it is good for photography, it is good for everyone in photography," takes into consideration not only the photographic industry elements but the consumer as well. Consumer interests, of course, run all the way from the federal and state government departments through large industries, motion pictures, television, advertising and graphic arts, medicine and public health, small industries, the microfilm and document copying, research laboratories, camera stores, the photographic department of the corner drug store, down to the individual who has photography for a hobby and the school child with a box camera.

Consumers are benefited by national standards for photography in many ways. Usually the consumer is not aware of the standards or the part they have played in providing him with better photographic materials and equipment at a lower price. When he uses an Ansco film in a Graflex camera resting on a Burke & James tripod using a Wollensak lens, a Kodak color filter, and a General Electric exposure meter, he seldom stops to think that all these various elements fit together and work together because of standardization.

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15. STANDARDS FOR TELECOMMUNICATIONS

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TELECOMMUNICATIONS is the broad field of transmitting information to distant places, usually by electrical means. The information can be in several different forms; written messages as in telegraphy, speech as in telephony, line drawings as in facsimile, and music and pictures as in audible radio broadcasting and television.

The fact that distance is a basic element in telecommunications constantly imposes the need for standards. Each communication path must operate as a unit in which the transmitting equipment, the interconnecting medium, and the receiving apparatus are designed to work together to deliver to the addressee in usable form the information entrusted to the system by the customer.

The technical difficulties in designing and building practical communication channels are myriad and often involve the necessity of compensating with one element for the shortcomings of another. Thus, the design of each component must be coordinated with all other features of the system to produce a useful result.

Commerical matters cannot be overlooked, for without traffic there is no need for a telecommunication system. Methods of making the terminals of the system available to the customers, rates of payment, apportionment of the receipts when more than one company or administration is involved, language difficulties, and many other problems not directly concerned with the technical operation of the service must be settled by agreements and standards. The extension of systems across national boundaries may add substantially to the number of questions for which answers must be found.

In practice, there are three major divisions of the telecommunication field: telegraph, telephone, and radio. Their problems and utilization differ sufficiently to make separate sets of standards necessary even though they may share some features.

In Europe, owing to the many countries, languages, and other differences involved, it has been found expedient to set up a permanent international organization whose sole efforts are standardization.

Only about two decades after the introduction of the telegraph, the International Telegraph Union was set up in Europe in 1865 to provide for the interworking of these systems. Advanced standards for international telecommunications of all kinds including telegraph, telephone, and radio were fist introduced some thirty years ago with the creation of the Comité Consultatif International (CCI). Its activities are based on recommendations that are revised periodically to take care of new or changed requirements and technical developments.

Recommendations for international standardization concentrate on the essential clauses in specifications for performance rather than on attempts to standardize rigidly any piece of apparatus. The different operating administrations incorporate such requirements in their specifications so that the equipment provided will permit the standards of performance to be adequately realized.

International Telecommunication Convention

The International Telecommunication Convention was drawn up in 1932 by a conference of plenipotentiaries of the contracting governments. It lays down the general principles governing international telecommunications, and the participating parties must accept at least one of the sets of service regulations that are annexed to the convention.

The convention itself deals in particular with such questions as arbitration, language, secrecy, monetary unit, establishment of consultative committees, and matters pertaining to the Bureau of International Telecommunication Union.

Telecommunication is defined as "any telegraphic or telephonic communication of signs, signals, writing, facsimiles, and sounds of any kind, by wire, radio, or other systems, or processes of electric signalling or visual signalling (semaphores)."

The convention is completed by regulations that are revised as necessary by administrative telecommunication conferences, which are scheduled for intervals of about five years, although wars and other contingencies have interrupted this sequence.

A conference is attended by delegates sent by governments, by representatives of private enterprises operating public telecommunication services that are recognized by contracting governments, and by observer-experts sent by other telecommunication services.

INTERNATIONAL TELECOMMUNICATION UNION

The convention states that the countries that are parties to it form the International Telecommunication Union, and further that the convention shall be completed by sets of regulations on telegraphy, telephony, and radio communication.

These regulations may be revised by administrative conferences attended by delegates of the contracting governments. A conference may admit the participation in a consultative capacity of those representatives and observer-experts whose interests may be affected by the decisions of the conference.

Each conference fixes the place and date of the next meeting. Two separate conferences are now held, one on telegraphy and telephony and the other on radio communication.

The central office is called the Bureau of the International Telecommunication Union and is located at Geneva, Switzerland.

Administrative conferences have set up consultative committees for the study of questions relating to the telecommunication services. On such questions, these committees draw up recommendations, which in due course are submitted for the consideration and approval of an administrative conference. These recommendations have no executive authority until approved by such a conference, although in practice they are not infrequently applied in advance of formal approval.

There are three such committees: Comité Consultatif International Téléphonique (CCIF), Comité Consultatif International Télégraphique (CCIT), and Comité Consultatif International des Radiocommunications (CCIR).

CCIF

The Comité Consultatif International Téléphonique is charged with the study of technical and other questions involved in operations and traffic in international telephony. It is made up of plenary assembly, committees of rapporteurs, the laboratory of the European Fundamental System of Reference for Telephone Transmission, and the general secretariat.

The plenary assembly controls the general activities and fixes the dates of the meetings. The committees of rapporteurs study new questions and submit reports and recommendations to the plenary session.

The European Fundamental System of Reference for Telephone Transmission serves as a center for transmission measurements and to coordinate transmission data relating to the telephone systems of European countries. It makes tests for administrations and operating companies and at the request of the plenary assembly or committees of rapporteurs it conducts experiments and tests relating to new questions.

The master reference system for telephone transmission on which the work of the laboratory is based was designed, constructed, and installed by the Bell System and is a replica of its standard system. Thus the primary standards of Europe and of the United States are identical.

It is significant that within the past thirty years, at the start of which the Comité Consultatif International was created, the world's telephones have increased from some 26 million to over 89 million, a 340 per cent increase, and the telephones throughout the world not connecting with the Bell System here in the United States have decreased from 8,600,000 (33.4 per cent as of thirty years ago) to 3,500,000 (3.9 per cent as of January 1, 1954); an improvement of practically ten times within a growth of over three times. In Europe, similar improvements have been accomplished during the past thirty years. In the mid-twenties, some 21 per cent of the telephones were accessible to international interconnection and this proportion was expanded to 79 per cent in the next ten years. Today, it is practically 100 per cent.

CCIT

The Comité Consultatif International Télégraphique is charged with the study of those technical and operating questions relating to telegraphy that are submitted to it by administrations and private enterprises, and also with the study of tariff questions proposed by an administrative conference.

CCIR

The Comité Consultatif International des Radiocommunications is charged with the study of technical radio-electric questions and operating questions depending for their settlement principally on considerations of a technical nature.

Centralizing administrations are set up to undertake the study of, report on, and draft recommendations for each particular question.

RATES

It has been agreed that the public is entitled to use the world's telecommunication systems and that it must pay for this service. No matter what coin of the realm may be handed over, the standard unit of the gold franc is used in international settlements, being a quantity of gold having a weight of $^{10}/_{31}$ of a gram and a fineness of 0.900. This is a basic standard designed to provide conversions among the many monies of the world.

Without giving the complete rate schedule for telephone service, it may be stated that international long-distance rates have been standardized on this gold-franc basis. Provision is made for ordinary, urgent, person-to-person, and reduced night rates.

As an example, for ordinary day calls, which may involve some delay according to distance, the basic rate is 1.60 gold francs plus a supplementary charge of 0.60 gold francs per 100 kilometers. For urgent calls, the basic rate is triple with the same kilometric supplement as for ordinary calls. The above rates apply on a station-to-station basis.

Telephony

All the telephones in the United States are operated under private ownership. The Bell System, through the American Telephone and Telegraph Company and its twenty principal telephone subsidiaries, operated about 82 per cent of this country's telephones on June 30, 1955. There were approximately 4840 other privately owned companies operating about 8 million telephones. A total of 54,315,000 telephones is included in both the Bell and independent systems.

From the foregoing, it is evident that only chaos would ensue if it was not for coordinated standardization, which is and has been over the years an important function not only of the Bell System but also of all the independent telephone companies. This is particularly necessary because long-distance calls between the various independent companies are connected through Bell System networks. Furthermore, the Bell System standards have world-wide recognition.

The United States Independent Telephone Association (USITA), representing almost all the independent telephone operating companies in the United States, is vitally interested in the standardization of operating procedures and the technical aspects of the interconnections among the various properties involved.

Standardization of operating procedures has made possible the expeditious handling of the great volume of short-haul and long-distance traffic that has developed during recent years. In fact, the accuracy and speed of service, which have contributed much in developing national community interest, is a direct result of standardization efforts.

On the technical side, the standardization of signals and tones along with uniform quality of transmission are, of course, necessities to an integrated national telephone system. Coordination of area and exchange numbering plans within a nation-wide master plan enables the member companies to cooperate smoothly and efficiently for both customer and operator dialing.

The United States Independent Telephone Association sponsors standing and special committees that operate on a national scale, and its various state associations may appoint committees as necessary. Problems relating to interconnections of operating facilities may be referred to the state or national committees for consideration and recommendation of policy. These committees accumulate and evaluate appropriate information and disseminate the resulting reports and recommendations to the associated members.

Since it may not be economically feasible for all the member operating companies to maintain large technical staffs, the association provides a useful medium for the collection and exchange of information that otherwise would not become available promptly to the smaller organizations.

RECORD COMMUNICATION

Record-communication systems deliver a message in written form and usually include telegraphy, both manual and automatic, and facsimile methods of transmission over wire or radio paths.

ORGANIZATION

A major portion of the world's transoceanic telegraphic message traffic is handled by British and American cable companies that have organic control of both ends of their circuits. Use of prescribed terminal and repeater apparatus, keyboards, codes, and circuit-maintenance standards on the major intercontinental traffic routes thus by-passes any necessity for international compromise to secure compatibility of terminal operations.

Radiotelegraphy enjoys organic unity to a much smaller extent; hence its problems of keyboard, equipment, and transmission compatibility are ubiquitous and sometimes acute. The tendency is toward extending to extra-European services the standards adopted by the European telegraph administrations for traffic interchange and joint manipulation of circuits.

The European telegraphs, wire and radio alike, employ common standards developed by international agreement through the international consulting committees, CCIT and CCIR, on telegraphy and radio, respectively.

MESSAGE FORMS

The United States and Canada employ essentially the same forms and tariffing for internal telegrams and for those exchanged between the two countries. The forms and word-counts are different from those employed under European and extra-European regulations. Overseas messages usually undergo transliteration from one form to the other at some point in international transit, the exception being where there is organic control as mentioned above.

Message texts, of course, remain unchanged between origin and destination. This circumstance has given rise to a proposal that texts be given through handling by means of reperforation at points where the preamble (the remainder of the message) has to be paraphrased manually. Difficulties regarded now as insuperable prevent this, due to hazards of separating texts from preambles.

KEYBOARDS

There is a general tendency to adopt an international alphabet (Baudot) and an international Morse alphabet for all printers and associated keyboards. However, incompatibility exists among world-wide systems of telegraph communications using 5-unit and Morse codes, respectively.

Within the area of 5-unit operation, the leeway afforded by keyboard options under the Baudot alphabet is sufficient for any two countries to communicate without difficulty. When general international networks like those of Europe and America are involved, standardization is difficult.

The keyboards used in the United States and Canada by the telegraph companies differ from those used for the teletypewriter exchange service (TWX), not yet internationalized. Both of these different keyboards in turn differ from the European teletypewriter exchange service (TELEX).

Both teletypewriter exchange operations, while incompatible for direct connection, are amenable to reperforator-converter automatic translation but at present that process is expensive.

PAGING

Printers are of two types: page printing and tape printing. Both the American and European commercial telegraph standards are for tape printing, the exception being that the teletypewriter exchange systems are page printing generally. Translators and controls to convert either type of keyboard preparation to the opposite type of printer functioning are available.

SPEEDS

The European standard of machine transmission speed is 50 bauds with impulses of 20-millisecond duration. American practice is generally to transmit at 45.6 bauds with 22-millisecond pulses. These speeds are sufficiently close to be compatible on circuits of short length. Recently, American practice is reaching for 75-baud speeds and higher.

FREQUENCY BANDWIDTHS

Most commonly, a band extending up to 2500 or 3000 cycles is a “vehicle” band that provides a broad highway to accommodate a number of printing-telegraph channels. Within the United States and Canada, there are two common plans for subdividing this speech band. In the one, largely used for private and leased-circuit services, the telegraph channel separation is 170 cycles. The other is largely used for the handling of domestic and international messages and the channel separation is 150 cycles. In England and on the continent, a channel separation of 120 cycles is widely used. There are perhaps two basic reasons for the reduced channel separation used in Europe. The reperforator operation method was adopted early and it admits of regeneration, with the result that slightly degraded signals are easily rebuilt. The second reason is that the distances involved are not so great as in the United States.

The reperforator method with its attendant temporary storage of information on paper tape makes adherence to through-circuit standards throughout the world unnecessary. At international borders, or more rigorously at international traffic exchange points, the telegraphic information is literally retransmitted onto a different telegraph system, the only requirement being that the stored information, common ground between the countries involved, is transmitted by the Baudot code. The same 5-unit Baudot code is easily converted by the addition or the dropping of "start and rest" pulses for the use of self-synchronizing systems as employed on ocean cables and international radio links and for use on "start-stop" teleprinters and teletypewriters.

FACSIMILE

In facsimile transmission, the one common denominator again is the width of the telephone speech band. Special wide-band channels to permit facsimile and telephoto systems to operate at high speeds have met no wide acceptance as yet either in the United States or abroad. Until the facsimile method of working becomes much more widely used, broad bands will be out of the question for international use except for telephotography, which can support a high tariff rate. International radio telephotography depends almost exclusively on retransmission for distribution to press-association subscribers on wire networks.

Radio

Radio signals are transmitted through the outer spaces enveloping the earth. Traveling at the speed of light, some go only short distances while others completely encircle the earth. Radio signals cross international boundaries, but unlike a traveler who submits to the customs and immigration regulations of a foreign land nothing can be done to stop radio signals at the frontiers. The world may be politically subdivided but the geographical boundaries mapping the sovereign domain of one nation from another have no meaning whatsover to a radio wave.

It is evident therefore that international standards are required to promote an orderly and effective system for the management of the many and inextricable telecommunication problems resulting from the natural behavior of radio signals and the differences among people. The nations of the world have mutually established such standards through the convention and the regulations of the International Telecommunication Union and in particular its Comité Consultatif International des Radiocommunications.

The convention lays down basic principles by which the contracting governments have agreed to regulate themselves in such broad matters as languages, settlement of differences, the public right to the use of telecommunication services, secrecy of communication, monetary units, radio regulations, use of the radio spectrum, and the establishment of consultative committees and bureaus designed to assure effective implementation of its precept.

Building upon the basic structure of the convention, the contracting governments have evolved specific radio regulations that are the international standards governing radio operation and without which a chaotic state would surely develop.

To communicate effectively, the many-tongued peoples of the world must have certain basic standards of language or understanding. The radio regulations have provided means for crossing the language barrier in several ways. To the man in the street, the abbreviation QRD means absolutely nothing. To a radio operator on a ship, this abbreviation in query form means, "Where are you bound and where are you from?" In answer form, a coastal-station operator is told "QRD Bangkok-San Francisco." No matter that through their native tongues these two persons could not communicate intelligently. The Morse code used to transmit the QRD abbreviation is a language unto itself and is the native tongue of no man. The Morse letters SOS signify distress in radiotelegraphy. The spoken word MAYDAY (coming from the French *m'aider* meaning "help me") signifies distress in radiotelephony. Such basic standards of understanding used in international radio operations stem from the activities of the International Telecommunication Union.

All nations must accord standard treatment to confidences contained in international messages and must not disclose their contents except to the addressee. Without such standard world-wide understanding, international communications concering competitive activities such as commerce would be harassed to the point of having no value.

To assure maximum effectiveness for the world-wide mobile services, the convention has provided the classical operating standard that all such stations ". . . shall be bound within the limits of their normal employment to exchange radio communications reciprocally without distinction as to the radio system adopted by them." Thus, although competitive entities may employ different systems, they are charged by this standard provision to intercommunicate wherever possible.

The radio-frequency spectrum lies between the highest frequencies of sound and the lowest frequencies of light. There is only one radio spectrum, and man cannot create another. Consequently, he must establish standards that provide for maximum use of that spectrum.

There are many classes of radio stations. Some are engaged in point-to-point public radiotelegraph and radiotelephone services, others in maritime and aeronautical mobile communication, broadcasting, radio navigation, and in many additional fields. The radio spectrum has been subdivided by the regulations so that certain portions are allocated to specific services for which they are suited. A station of one class may not occupy an area reserved for another service.

Within these allocated portions of the spectrum, individual stations are assigned to specific frequencies. Technical standards of operation require that no transmitter may wander from its assigned frequency or take up too wide a band of frequencies. For example, these standards allow a broadcasting station operating on a frequency of 1500 kilocycles (1,500,000 cycles) per second to deviate not more than 20 cycles from its allocated frequency. Without such standards, one station might interfere with another and the impact of this collision would instantly be felt by the listeners of both.

Nature has contrived a set of conditions—often capricious—that dictates that radio-wave propagation varies according to daily, seasonal, and sunspot cycles. Even here, the standards of one bureau of the International Telecommunication Union, the International Frequency Registration Board, undertake to verify the frequency reservations desired by the participating governments in terms of such daily, seasonal, and sunspot changes; all in a manner calculated to minimize interferences and secure the greatest possible use of the spectrum.

The governments of the world have undertaken to enforce the adopted standards through employment of monitoring stations. Let a station stray from its assigned frequency and the radio-spectrum policemen are sure to hand out a ticket.

The regulations provide for the establishment of standard transmitting stations operating on frequencies of 2500, 5000, 10,000, 15,000, 20,000, and 25,000 kilocycles per second. These standard-frequency stations radiate energy on these precise frequencies, so that stations all over the world will have exact references for the calibration of their measuring equipment which in turn is used for the calibration of frequency-control devices integral with each radio transmitter. These stations, in addition to the transmission of standard radio frequencies also transmit standard audio-frequency tones, time signals, and information concerning propagation conditions.

The power of a radio transmitter must be kept to the minimum necessary for the proper conduct of its business. Standards have been evolved to approximate the quantity of energy that will be delivered to a receiver by a transmitter of known power using an antenna of known characteristics. All these things enter the engineering considerations of frequency assignments and utilization.

To establish communication between two points as in the case of public radiotelegraphy and radiotelephony using complicated systems of multichannel operation, it is at once evident that the transmitting and receiving terminals must be compatible; that is to say, from the standpoint of technique the same system must be used at both terminals. In such cases, the International Telecommunication Union does not set up standard systems of operation. This is left to the governments or private agencies involved because it has been wisely foreseen that hard and fast international rules and regulations containing such standards will throttle development in this relatively new and vigorous radio art.

Standards as a measure or as an example for comparison are being constantly developed and changed—an interesting illustration of which is the recent prolonged debate in the United States concerning standards for television in color.

16. SAFETY STANDARDS—A DEMONSTRATION OF INDUSTRIAL SELF-GOVERNMENT

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VOLUNTARY adoption and use of safety standards—developed with full and free participation of all the affected interests—is the highway to self-discipline, freedom from accidents, and true freedom of enterprise.

Safety and Accidents

Accidents, as the term in used in this essay, illustrate failure to provide complete controls. Accidents are not limited to chance failure. Chance suggests completely random actions directed toward their own ends without thought of control against mishap. The probability of completing, without accident, any number of actions conducted at random is a function of the action undertaken, and the history of accidents that have been recorded in the failures to complete the actions.

When one studies the history of accidents, one sometimes discovers that accident causes have been controlled enough in a many-times-repeated operation so that the likelihood of an accident in that operation has been reduced to almost zero. It is now within the range of statistical probability that the management of such an enterprise can predict an almost accident-free result.

What does this lead us to? Actually there are two approaches to safety. First, the development and control of operations to conduct them successfully as planned with a high degree of certainty, as has been done in such fields as the utilization of nuclear energy; second, the prevention of mishap in operations to a predictable degree of certainty, as in mining disasters. The first is discipline. The second is a guarding action. I label this distinction because both approaches have to be used in actual practice and will always have to be used in the development of disciplines which are set up to assure the attainment of objectives.

What may be more important at the moment is the realization that accidents need not be a chance thing, statistically derived through the application of the law of large numbers and theory of probability. On the contrary, management can plan actions and can control them within predictable limits, irrespective of the inherent danger of mishap and injury that has been revealed by the history of accidents. While accidents may continue to be a function of danger, safety is a function of management. The principle implied is that maximum operating efficiencies are not reached until accidents are held to a minimum.

Safety to the public, as a consuming group using the products and services that have been distributed, is outside the area of direct control. However, the influence of management by means of its planned safety program has been made to extend to the public in two principal ways. First, through the design and construction of its goods and the operation of its services so that they can be used as planned—a predictable long life without mishap. Second, through industry-conducted safety education and training programs for the consuming public.

In the course of production and consumption of goods and services, people frequently take great risk, sometimes unnecessarily, because possible gains appear to be considerable. Moreau de Saint-Méry, an emigrant at the time of the French Revolution, said that the sailors on American ships seemed to take great and unnecessary chances with their lives for the mere joy of it!

It is no part of my intention to seek a safety that makes one a coward, living a life devoid of thrill, adventure, or gain. It is my intention as a safety engineer to seek and establish the standards by which human activities may be evaluated and the safe completion of an increasing number of actions or operations may be brought within the range of predictability. Management methods and industrial engineering will provide the principles by which most wealth-creating operations can be guided successfully without mishap. Perhaps psychology will offer the remaining know-how so that in time people will be less prone to chance an accident. In any case the knowing minds concerned with an oft-repeated action can be brought together, and the one best way to perform that action can be discovered and described. Where the one best way reduces the risk, but increases the cost out of all proportion, something less than the best way can be agreed upon as a compromise—the best that is needed in all the circumstances. Thus we direct a safety program to the development of standards.

Standards

A safety standard is not usually the natural consequence of evaluating some experimental evidence scientifically derived. In contrast, the standard weight of a pound, or the potential of a volt, while compromises, have scientific definition, and can be demonstrated by reproducible experimental evidence. The safety standard is the most practical, currently available, acceptable opinion founded in the experience of those who contributed to the evaluation and compromise.

It is often found that the older a standard is, and the more frequently it has been re-examined for modernizing, the more likely it is to be founded in objective evidence. Conversely, the younger it is, the more likely it may be a desirable aspiration that is not yet fully practicable. This wide variation in specific validity does not in any way vitiate the value of the younger more loosely drawn standard. Many practices have not been brought under the scrutiny of standardizing bodies for the expressed reason that they were not considered ready to be standardized.

One of the important contributions made by the principal groups drafting safety standards, listed at the end of this essay, has been to encourage the establishment of standards as soon as there was any reasonable basis for them. There are two reasons for hastening to bring projects to the standards forum: (1) the existence of a standard encourages people to use it, and thereby helps to prevent some accidents, and (2) it is easier to revise existing standards than it is to establish the standard in the first place.

Safety standards are the best acceptable opinion of the groups that drafted them. The fact that standards have been forthcoming out of deliberations of need and individual ingenuity to meet the need, rather than by a great weight of experimental evidence, leads to the fundamental philosophy which underlies ASA's consensus principle. Simply stated the consensus principle means that all who are legitimately concerned with a project have the right not only to be heard but also to be recognized as having competence to contribute their experience and their opinions, which opinions cannot be overruled merely by a majority vote.

Strong emphasis should be placed upon the idea of participation by all legitimately concerned interests. Conceivably manufacturers, as well as users, of safety devices could agree on a set of specifications. These could operate to a standard suitable to both parties. But there are other interested groups such as labor and insurance companies which are competent to offer their experience within the consensus principle. Therefore, the practice has been to seek the broadest possible spread of interest.

A standards drafting committee considers its votes with a view to determining: (1) the weight of a single economic interest, to prevent domination by a pressure group, (2) the relative experience of those casting the negative votes, (3) the impact of the standard upon the economic status of those casting the negative vote, and (4) the objectivity of the affirmative vote.

There are presently nearly 200 American Safety Standards which have been developed and promulgated under the procedures of ASA. From "Abrasive Wheels, Use, Care, and Protection, B7.1" to "Xylene, Allowable Concentration, Z37.10," the titles of safety standards run down through the alphabet. In chronology there are such standards as "B13, Logging and Sawmill Safety Code," issued in 1924. Year by year the list has been augmented until it has reached its present impressive length.

The scope of the specific matter covered by these safety standards is vast, but an examination of the standards reveals that to fill in the gaps will be a considerable undertaking. There is actually no limit in sight for their expansion. The American Society of Safety Engineers as a matter of policy has assumed leadership in this matter. To name just a few of the areas not presently covered by national safety standards, here is a sample taken from an earlier paper.[1]

1. Explosion: There are standards neither for such hazardous materials as zirconium, titanium, barium, chlorates and perchlorates, hydrides of boron, and aerosols, nor for such pressure generating equipment as tar kettles, and wall paper steamers.
2. Collapse: Standards are needed for pre-stressed concrete beams, pressure grouting, factors-of-safety in design.
3. Point of Operation Machines: No standards exist for molding and injection presses, tannery, and leather-working machines, to name only a few.
4. Electrical: There are no standards for electrostatic deposition of sprayed paint, high voltage testing of equipment, and other processes and devices.
5. Atomic energy: The developments in the utilization of atomic energy open up a whole field of need for standards as atomic materials and processes become available to industry.
6. Miscellaneous: There is a need for standards of management and organization, standards of maintenance, and many others.

The safety standards which we now have are the product of attrition. They are entirely the practical, compromise, consensus result of deliberation and debate. The object in all cases has been to define a safe condition, that is, safe to the extent that the physical circumstances make an operation safe. Safety standards represent primary controllable conditions that are inspectable and demonstrable. Thus they are enforceable. It is to be noted that they are not operating rules. When I use the word "enforceable" I mean that the discipline of compliance can be controlled. This degree of making operations safe is management's responsibility. It is my thesis that self-discipline and industrial self-government can exercise control sufficiently to obviate policing in most instances. This is only half the story of discipline, as will be seen in a later paragraph.

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[1] Nicholas Prasinos and Arthur S. Johnson, "What Can Be Done About It? (Analysis of Safety Standards Generally Available)," in "Uniform Standards for Machinery Guarding and Protective Equipment," *Transactions*, 41st National Safety Congress, National Safety Council, Vol. 16 (1953), pp. 119-33.

There is another class of safety standards not so directly related to the physical conditions of work and not so easily administered. They are standards none the less, although the difference is marked. I refer to safe practice which defines the actions of people through operating rules. The National Safety Council is the principal source of safe practice standards. The program of the Council comprises a vast library of information revealing conditions which give rise to accidents and the solutions of the operational problems thus created. The solutions represent the experiences of many good operating safety men, and most of them find practical application. These solutions have not been developed under the "all parties at interest" procedure. In theory, shop supervision is intended to control the discipline in an operational plan. In reality, the limit of safe practice is in the willingness of the individual employee to do the best he can.

The trend has been and will continue to be in the direction of standards of safety in the designed operation, and away from safety attained through the adherence to safe practice. The total of safely designed motions to complete an operation is a function of its disciplines. To the extent that standards are applied industry-wide instead of to the operations of single plants and that "all parties at interest" contribute to the development of the standards, adherence to the discipline will be more likely.

There is a vast library of currently useful safety standards produced by the previously mentioned standardizing agencies; some of these standards are clearly the one best way designed by specialists and founded upon experimental evidence, while others are the opinions of experts. It is not demonstrable in all cases that "all parties at interest" were consulted in the development of these standards but many of them have provided the basis for the development of American Standards and have been given the stamp of ASA approval.

There is still another type of safety standard which, although of great importance, is not usually brought to the status of an American Standard. I refer to the standards used by testing laboratories in the certification and labeling of apparatus. Here, the purpose is to certify the safety of the product to its users. Clearly, sound business judgment would dictate that a product should in fact be safe when internal disciplines result in expressed or implied safe product representations to the consuming public. If a product is unsafe, governmental controls may be imposed. For instance, certain highly flammable textile fabrics have recently been brought under control of federal statute.[2] This kind of control might have been averted if industry itself had recognized the need for certification and labeling and applied it through its own effort. It was a self-disciplinary matter which is now brought to statute. An American Standard has been available since 1952. The machinery of ASA is available to

[2] "Flammable Fabrics Act." 67 Stat. 111, 15 U.S.C., sec. 1191-2 (1952 Supp. 1).

extend the program of safety standards across workers', producers', and consumers' interests and to carry the principle of self-discipline through certification and labeling to great lengths in all these areas of interest.

A brief discussion of the position of the federal and state governments in regard to safety standards and their contribution to these standards is in order. There appears to be a trend toward granting enforcement agencies statutory authority to key regulations to existing standards of national acceptance. This is true with particular reference to American Standards and to those of some of the national standardizing organizations, such as the engineering societies. There is general agreement that this is better than using definitions developed by the enforcement agencies themselves. The trend appears to have encouraged some of the agencies, not yet specifically set up to adopt voluntarily written standards as regulations, to take verbatim texts from those standards as their own regulations. Any such actions which thoughtfully aim toward single universal standards will always be helpful.

In keeping with the proposition that the best standards come out of the collective minds of "all parties at interest," representatives of the several associations of state enforcement officials, and the departments of the federal government are included in the voluntary groups drafting standards. Probably some of the best technical minds in the field of accident prevention represent governmental agencies. These governmental representatives, serving as committee members, frequently submit valuable, objective, and well-received contributions.

COLLECTIVE ACTION

Several industries have developed safety programs through the staff action of safety committees of their respective associations. In all such cases with which I am familiar, both specifications that would make operations safe and descriptions of safe practice for workers are included in the programs. Because a close relationship has come to be recognized between production efficiency and safety, competition has forced individual companies to adopt their industry's program. In some industries, such as the iron and steel industry, the history of safety programs is a long and useful one, in others it is more recent. No industry has submitted its standards to the broad "all parties at interest" procedure prescribed by the ASA. I know of almost none that has brought around the council table labor, insurance, manufacturers of equipment, consumers of their goods, and government to make possible a natural, useful acceptance of the standards so drafted. The photographic industry is the dominant exception.

None that I know of has utilized an association, subsidiary to its several trade associations and engineering societies or independent of them, having full industrial membership and organized for the sole purpose of drafting the standards of self-discipline. The Industrial Hygiene Foundation is an agency of industry, but it is interindustry in its range of membership, and its scope is limited to specific problems relating to industrial hygiene. It nevertheless represents industry's effort to provide itself with the means to control this exposure. IHF develops its recommendations through the use of experimental evidence in the hands of specialists. It does not operate on the "all parties at interest" principle of standardization, although there is some movement over into ASA with the recommendations.

If the thesis that each industry should undertake to develop its own safety standards by the consensus principle can have any usefulness, it ought to aim at some idea which would tend to make practical those actions which in a limited way have contributed to safety in the past. It would not be necessary to reduce such an idea to a formula. On the contrary, it would be sufficient to develop it to a point of visualization. The action outlined below should provide the means for establishing an industrial standards program for self-discipline for all members of an industry who would adopt them and make them their own procedures.

Proposed Safety Organization for an Industry

A. *Object.* To take collective action on behalf of the organization's members pursuant to the fundamental policy to stop accidents.

B. *Scope.* Safety for the employees of the organization's members. Safety to the public which purchases the industry's products and services.

C. *Form of Organization.* There are visualized three classes of members: industrial concerns, trade associations, and governmental agencies. Such an inclusive group will provide the breadth of interest and competence necessary for the membership of the technical committees. Member companies would be concerns within the industry, as well as their suppliers and customers. The trade associations and governmental agencies interested and able to qualify will constitute membership in the two remaining classes.

D. *Basic Authority.* The constitution would state objectives, authority, and limitations. The by-laws would establish the Board of Directors and technical committees and their duties.

E. *Functions.*

  a. Research—Accumulation of the knowledge available, including existing standards, as a staff job of the organization together with the dissemination of the material.

  b. Basic Research—The development of experimental evidence for the drafting of new standards and the revision of old ones. Such research should be sponsored rather than conducted by the organization.

  c. Standards—The development, revision, and improvement of operating standards which would be the primary functions of the organization. The certification program should be within the framework of the ASA, with the organization as administrative sponsor in the ASA. The range of standardization could well be:

1. Safety Standards
2. Safe Practice
3. Methods of Testing
4. Nomenclature
5. Specifications for Materials and Devices

As suggested above the personnel of each technical committee dealing with standards should include representatives of all groups which have a substantial concern with the scope and subject of the standard under development.

d. Testing—Sponsorship of testing of the industry's product, and, possibly, the creation of an independent testing agency would probably be worth while. When certification is deemed desirable, the question of warranties, direct or implied, becomes important. It is relatively unexplored and will require much thoughtful consideration. The risks inherent in the use of warranties should not cause them to be shunned. My guess is that an industry bold enough to undertake certification, and do it well, will find it useful. Certification, however, is only one of a dozen testing functions that such an organization could employ to benefit the consumers of the industry's product. An organization exploring the possibilities in this field would do well to examine the availability of the ASA.

e. Patents—The ownership of patents is not fundamental to the functions of the organization. The matter should be left to the policies of individual members. Parenthetically, let me make a point concerning both patents and research. No activity of such an organization should be for profit, but all of the activities should be founded in the profit motive. Whatever is done, should be done to enhance the value of the goods produced and services rendered, as well as to assure safety. I do not suggest that any industrial organization spend money to make gifts of knowledge.

f. Information Service—It would be a staff function of the organization to prepare and disseminate information to its members. The scope of the service should be adjusted to the needs of the entire industry and not to those of individual members of the organization. Whether individual members and nonmember companies, associations, etc., would be able to purchase from the organization expert opinion or the services of its staff would be a matter of a policy decision.

F. *Financing.* The total cost naturally cannot be suggested at this stage. However, the caliber of staff required, normal current expenses, organizational grants for research, contractual arrangements with laboratories for testing, and other outlays suggest that such an organization would need $100,000 to begin operation, not $10,000.

An excellent example of industrial self-discipline according to the principles outlined above is provided by the National Fire Protection Association, an organization of almost universal interest. Its influence in protecting all property owners from losses by fire is so great as to make it in effect a public service organization. Somewhere between that vast entity and a simple safety committee within a trade association—of which there are a great many—can be found a range of operation that will help to create the program and standards by which industrial self-discipline can be achieved.

SAFETY STANDARDS DRAFTING BODIES

American Chemical Society
American Gas Association
American National Red Cross
American Petroleum Institute
American Society for Testing Materials
American Society of Mechanical Engineers
American Society of Safety Engineers
American Welding Society
Bureau of Labor Standards, U. S. Department of Labor
Bureau of Mines, Department of Interior
Council on Pharmacy and Chemistry of the American Medical Association
Edison Electric Institute
Manufacturing Chemists' Association
National Board of Fire Underwriters
National Bureau of Standards, U. S. Department of Commerce
National Fire Protection Association
National Safety Council
Portland Cement Association
Underwriters' Laboratories
U. S. Department of Health, Education, and Welfare.

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17. NATIONAL STANDARDS FOR AGRICULTURAL PRODUCTS

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NEED FOR UNIFORMITY in agricultural products has been accentuated in recent years by trends toward mass production, large-scale processing, integrated distribution, and mass merchandising. Such uniformity may be obtained by adjustments in production to achieve greater homogeneity of output, or, lacking success in this approach, from sorting the products into uniform lots. In agriculture today both approaches are employed extensively, but the problems of attaining uniformity are of such magnitude that the demand is not fully satisfied.

Farmers strive to satisfy trade demand for uniformity by adopting breeding, feeding, cultural, and harvesting practices designed to permit larger shipments of more uniform and better quality products to market. Their best efforts, however, fall short of the ideal because of the wide diversity of soils, climatic, weather, and management conditions under which they operate, plus the number of diseases and insect infestations to which their products are exposed. Even within producing areas where these factors are relatively constant, the natural heterogeneity involved in the growth of biological products is great compared with precision achieved in the fabrication of industrial products.

In view of these circumstances reliance has to be placed upon methods of sorting and selection among products available for sale. Personal inspection by the buyer represents the most elementary basis to select or evaluate the products, but it encounters two serious shortcomings. First, it is too cumbersome and expensive in view of the number of products and the distances between points of sale at successive stages of marketing. Second, a large share of the value or quality may be dependent upon internal factors that cannot be judged by visual inspection or by convenient field testing. These difficulties suggest the desirability of establishing national standards for grades of agricultural products and the importance of reliable unbiased inspection services to certify product quality according to these standards.

Preliminary to a consideration of quality grading it is necessary to recognize the problems of product identification in agriculture. Identification may have to take into account the several types, species, breeds, varieties, or strains that exist within each kind of crop and livestock product. Such subclassifications usually have distinctly differentiated characteristics of significance in market evaluation, but this means of classification cannot be completely relied upon as a measure of quality. Being of biological origin and subject to diverse growing conditions, variation within the subgroups frequently exceeds differences among them. Variations associated with soil and climatic conditions are so pronounced in some instances as to require identification of the producing area along with kind and quality designation, as is illustrated by such market descriptions as *Long Island* Potatoes, *Idaho* Baking Potatoes, Fancy *Washington* Delicious Apples, or Grade A Large White *Nearby* Eggs.

Although much progress has been made toward the establishment of widely accepted means of describing kinds and qualities of agricultural products, the job is far from complete or satisfactory. This should not be surprising in view of the literally hundreds of products that are shipped and traded in carlot quantities (e.g., ninety-eight kinds of fruits and vegetables are received in carlots in New York City) and the wide array of quality factors related to them. Among those factors which vary in importance with different products are size, shape, color, purity, palatability, tenderness, firmness, strength, maturity, finish, and freedom from blemishes, as well as moisture, oil, protein, sugar, or acid content.

So many quality attributes enter into consideration of market value and buyers have so many differences of opinion as to what constitutes quality that it is sometimes difficult to develop useful grade classification. The lack of objective measures or of instruments or devices for making measurements within the limited time or under conditions available for practical grading, contributes to this situation. The demand for simplicity in terms of relatively few grade classifications, each necessarily including a fairly wide range of quality, leads many buyers to rely on inspection of samples or of whole lots even though recognized grades are available. Nevertheless, nationally standardized grades have been found to be imperative for many types of market transactions that occur in modern commerce as well as for the reporting of market information.

GROWTH TOWARD NATIONAL STANDARDS

The need for a common language to describe quality of agricultural products underlies the development of national standards and was first expressed in the so-called "trade" or "commercial" standards. These trade standards grew out of quality distinctions made frequently enough by buyers and sellers to result in widespread employment in trading and trade parlance. They still are used today with success where the flow of products between individual buyers and sellers is sufficiently continuous to maintain a meeting of minds regarding the quality of product desired and being delivered. They were used before specialized inspection services were available, and are still used where official certification of grade is considered too expensive or impractical to use.

The trade standards tended to originate in different local markets independently, and varied between markets as well as from time to time within markets. Efforts were made by governing bodies within some markets to achieve greater consistency of terms and their meanings. For example, in Liverpool during the early 1800's and later in markets in the United States, cotton standards were evolved, based on samples of cotton used for guidance of the trade. By 1856, the Chicago Board of Trade was making use of specialists to inspect and certify the quality of "provisions" and flour; and, in 1857, grain inspectors were appointed. This kind of service was soon established in other organized markets and extended to other commodities. At first evaluation of quality was left to the expert opinion of inspectors, but soon committees of trade members were formed to prepare written definition of grades.

Between 1871 and 1916, nine grain-producing states established state standards for grain and state grain inspection services. Following grain, similar services were introduced on other commodities by these and other states. In 1920, records show that fifteen states had apple grading laws. Nevertheless, the lack of consistency in grading, within and between markets and states, served to indicate the need for national standards to facilitate both domestic intermarket and international trade. In general, processors and distributors who needed dependable quality pressed for high, well maintained standards, while traders who were dependent upon volume of business, sought more flexible standards to attract shipments to their markets. When the U. S. Department of Agriculture was authorized to provide standards for grades and inspection services, many federal-state cooperative agreements were made to coordinate these inspection services, which are now available on most agricultural commodities throughout the country. Also, most states have adopted the federal standards for use by their inspection services.

Market reporting, a service needed to attract shipments to central markets, was a strong early influence toward uniformity of grades. In 1726, the New York *Gazette* carried market prices on wheat, beef, pork, and naval stores, but gave no indications of quality. By the late 1700's, however, trade terms designating quality generally were given in the papers along with prices. For example, Dunlap's *American Daily Advertiser* of

Lancaster, Pennsylvania, in 1791, was reporting "prime Georgia tobacco," "first quality Boston beef," and "first quality rice." The *Federal Gazette* and Baltimore *Daily Advertiser* in 1796 gave prices on "prime New York pork," "second quality beef," and "first quality James River tobacco." During the 1800's a number of trade papers were established which specialized in reporting market information on agricultural commodities. Among them were the Cincinnati *Current,* established in 1844; the *Producers Price Current* started in New York in 1858; and the *Daily Drovers Journal* established in Chicago in 1873. Many of the terms commonly used to designate quality by these and other papers at the turn of the twentieth century still are found today in our official national standards. They include:

Grain—No. 1, No. 2, No. 3, and No. 4.
Upland Cotton—middling fair, strict good middling, good middling, strict middling, middling, strict low middling, strict good ordinary, and good ordinary.
Rosin—X, WW, WG, N, M, K, I, H, G, F, E, D, and B.
Beef—prime, choice, and good.
Potatoes—No. 1 and No. 2.
Canned fruits and vegetables—extra standard, standard, and seconds.

The Market News Service of the Department of Agriculture was started in 1915 and has given, and continues to give, impetus to the nationalization of quality standards. The conciseness and efficiency of its reporting is highly dependent upon reliable quality designations in terms of which prices and other relevant data can be expressed. This service daily gathers and provides through a nation-wide teletype system information on a large number of commodities. At present approximately 1000 daily newspapers, 1300 radio stations, and 100 television stations carry these reports. In addition, releases are made through distribution of mimeographed reports directly to interested market participants. Prices on livestock, cotton, grain, naval stores, and tobacco are reported according to official standards for grade promulgated by the Department. Prices on butter, cheddar cheese, eggs, fruits, and vegetables are reported according to statements of quality as given by the trade, and may be in reference to either trade or official standards.

LEGISLATION FOR FEDERAL STANDARDS AND INSPECTION

The first steps taken by Congress to provide for official national standards were a result of what writers of that period described as "chaotic conditions" in marketing grain. Between 1880 and the beginning of World War I, grain marketing was confronted with increasing difficulties: the grain standards and the interpretations of these standards differed among the states; certificates as to grade issued in one market were frequently not verified when the grain was offered for sale on another market; foreign buyers complained about the quality of grain received, and by 1906, conditions had deteriorated to the point where certificates of quality issued in some American markets were not honored abroad. Danger of losing part of our export market plus difficulties in marketing at home finally resulted in demands for federal supervision of grain inspectors.

Between 1903 and 1916, twenty-six different bills were introduced in Congress on the subject. Finally, the United States Grain Standards Act was passed in 1916, providing for (a) the establishment of official national grain standards, (b) federal licensing and supervision of the work of grain inspectors, and (c) with certain exceptions, mandatory official inspection and grading of all grain shipped in interstate or foreign commerce, which is sold by grade.

The task of mobilizing the nation's resources during World War I brought the Department of Agriculture directly into the development of official national standards together with the conduct of supporting inspection services on most agricultural commodities. The Cotton Futures Act of 1914 authorized the establishment of Federal Cotton Standards by the Department of Agriculture and made their use compulsory on the cotton futures exchanges. The United States Warehouse Act of 1916 gave the Secretary of Agriculture authority to establish and promulgate standards for certain agricultural products. This authority was later extended to cover agricultural products generally. An act to provide for the national security and defense in 1917 authorized the Department to investigate and certify to shippers the condition of fruits, vegetables, and other food products received at central markets. In the Annual Appropriation Act for the Department of Agriculture passed in 1918, provision was made for the investigation and certification of the quality and condition of food products, including the demonstration and promotion of the use of uniform standards. Similar provisions recurred for many years in subsequent appropriation acts. In 1919, the Cotton Futures Act was amended to prescribe, as a condition of exemption from a tax, that the form of cotton futures contract, now generally used, require the cotton tendered thereunder to be classified by Department inspectors. As a result, all cotton delivered in settlement under futures contracts is federally graded.

Numerous acts since then have further promoted the use of official national standards and the inspection service of the Department of Agriculture.

In 1923 the Cotton Standards Act provided that in all transactions in interstate and foreign commerce in which cotton is described by grade and staple, the description must be in terms of official cotton standards of the United States. Also the Naval Stores Act of that same year authorized the establishment of official United States standards for turpentine and rosin, and prohibited the sale of such commodities in commerce except under or by reference to these standards.

In 1927 the Cotton Statistics and Estimates Act required the Department to collect and publish periodic statistics on the grade and staple length of the cotton crop and the carryover on August 1 of each year. This necessitates grading representative samples of the crop and carryover by federal inspectors.

In 1928 an act was passed authorizing the Department to establish wool standards.

In 1929 the Tobacco Stocks and Standards Act required the Secretary of Agriculture to establish standards for the classification of tobacco, and to collect and publish quarterly statistics on the quantity of leaf tobacco in storage according to these standards.

In 1933 the Export Apple and Pear Act was passed to protect the reputation of these fruits in foreign markets by requiring that minimum standards of quality be established for apples and pears shipped in export and that all lots be inspected for conformity to these standards before shipment.

In 1935 the Tobacco Inspection Act provided for free and mandatory grading of tobacco on all auction markets where a grower referendum indicates a desire for such service.

In 1936 the Grain Futures Act of 1922 was amended, among other things, to change its title to the Commodity Exchange Act and to require that the delivery of commodities under futures contracts conform to official United States standards, if such standards have been established. The act now applies to about twenty commodities including cotton, wool, butter, eggs, and potatoes.

In 1937 the Smith-Doxey Act provided for free grading according to official national cotton standards for grower-members of groups organized to promote the improvement of cotton quality.

In 1939 the Federal Seed Act authorized the Department of Agriculture to fix standards to be met by imported live seed under certain circumstances and to promulgate standards of germination for each kind of vegetable seed.

In 1946 the Agricultural Marketing Act restated the responsibility of the Department of Agriculture to develop national standards and to issue certificates of quality on agricultural products. It directed that fees be charged for inspections authorized by the act, and that such fees, as nearly as possible, cover the inspection costs, provided the fees are reasonable from the point of view of facilitating trade and marketing agricultural products to the best advantage. It also provided that certificates issued be received by all courts of the United States as prima facie evidence of the truth of the statements contained therein, and that standards for procuring agricultural products be developed for use of federal and state agencies.

Closely related to these acts, under which the Department of Agriculture carries on its standardization and inspection work, is the Federal Food, Drug, and Cosmetic Act, enacted in 1938, to supersede somewhat similar legislation passed in 1906. Under this Act the Department of Health, Education, and Welfare establishes standards for use in their work of insuring that foods are pure and wholesome. It also provides for the establishment of standards of identity, quality, and container fill to promote honesty and fair dealing in the interest of consumers.

In all of this legislation considerable latitude is afforded for administrative decision in determining or amending the standards and nomenclature for particular grades.

PROCEDURE FOLLOWED IN DEVELOPING OFFICIAL NATIONAL STANDARDS

The development and maintenance of standards of quality always include a certain amount of trial and error. First, a start is made with information gleaned from the trade and others as to what is quality and how it is judged; then work is continued through redrafts, surveys, hearings, and amendments toward the ever-changing goal of a standard best reflecting the interests of all concerned.

Any interested person has the right at any time to petition the U. S. Department of Agriculture for issuance of a new standard or amendment or repeal of an old one. When sufficient interest has been expressed in a particular standard, development work is initiated, and pertinent information is gathered by observing production and marketing practices and meeting with producers, wholesalers, processors, retailers, and consumers. Experience from work with other commodity standards is used. Also, the inspection services are able to provide valuable information. Scientists of the Department, state colleges, and universities are consulted on such matters as types of damage done by insects and disease and the latest scientific tools for measuring product characteristics.

Following these investigations, which may take anywhere from a few months to several years, a proposed standard or amendment, as the case may be, is issued and published in the Federal Register. Sometimes these proposed standards are tried through several crop seasons, and the time they are kept as proposed standards varies, but never less than thirty days. During this period interested persons are given an opportunity to submit data and views regarding the proposal. Hearings are sometimes held to obtain oral discussion. All pertinent material is studied and the proposed standard or amendment redrafted in line with new evidence. Then the new standard or amendment is signed under authority of the Secretary of Agriculture and becomes official.

PROBLEMS IN DEVELOPING OFFICIAL NATIONAL STANDARDS

Different uses and ways of using agricultural commodities often require different product characteristics, and because of this, separate standards are sometimes needed to serve each of the principal end uses. For example, those who want fruits and vegetables for fresh use emphasize different characteristics than those who want them for canning or freezing. To accommodate both, separate standards have been established for each purpose. In tobacco special demands exist for those parts of the crop grown and cured in different producing sections. To accommodate these demands, official standards first divide all American grown tobacco into seven classes; each of the classes is further divided into from two to six types; and each type is then subdivided into grades. Another way of segregating products according to uses in standards is illustrated in the standards for carcass beef. For this commodity there is only one set of grades, but different grades have become identified as best suited for different uses. The highest grades—Prime, Choice, and Good—measure palatibility of fresh meat when cooked, of which the fat within and between the muscular tissue is an important indication. The lowest grades—Cutter and Canner—are used in the manufacture of processed meats; for this purpose, excess fat is undesirable. The intermediate grades —Commercial and Utility—may be diverted to either use depending on relative demand.

Even when individual grades or sets of grades distinguish products according to principal uses, there is seldom complete agreement among buyers as to what constitutes quality. Some people concerned with this lack of agreement have recommended that instead of grades the more important commodity characteristics be described individually. However, the simplicity of using grades as a common language in marketing apparently has advantages over the more complex method of describing individual characteristics, and the demand for standards for grades has persisted.

How to combine different measures of a product's attributes, on which there is general agreement, into a single measure called a grade is a critical problem. Most standards for grades promulgated by the U. S. Department of Agriculture describe those product characteristics that each grade should possess and the extent of various defects permitted. Sometimes a deficiency in any one of several characteristics puts the product in a lower grade. In other standards, particularly those for butter, cottonseed, and processed fruits and vegetables, important characteristics contributing to or detracting from quality are given ratings or scores. A combination of the ratings then gives the grade.

The relative importance assigned to each characteristic in standards for agricultural products usually is determined by a subjective balancing of opinions obtained from producers, traders or handlers, processing plants, and consumers. In a few instances, the contributions that individual characteristics make to quality have been estimated by statistically measuring the effect each characteristic has on market price, but these results have never been used in official standards.

What proportion of a product should be classified in each grade—that is, where the dividing lines between grades should be drawn—has been largely resolved from the point of view of making the grades of greatest use. In December 1950, beef grades were revised to make the Prime grade a working grade by increasing the proportion of beef falling in it from less than 0.5 per cent to about 10 per cent, and to increase the usefulness of the Commercial grade for trading purposes by narrowing the range of quality it covered. On fruits and vegetables for fresh use, greatest use of the standards usually seems to result when grades are established so that approximately 60 to 80 per cent is classified as the No. 1 grade, 15 to 25 per cent in a higher Fancy grade, and the remainder in lower grades. If too much is in the superior grade it may fail to bring the premium necessary to cover costs of sorting. There never has been much enthusiasm for putting large quantities in the lowest grades. What distribution of a product by grades would bring greatest net returns depends upon the price-supply relationships by grades. As yet, only limited attempts have been made to study these intra- and intergrade price-supply responses for particular commodities.

How often standards should be amended to keep up to date varies with circumstances. Some have remained unchanged for twenty years, others require amending within a few months. Farmers and traders sometimes express the desire to have standards relaxed in years of low quality, but the practice has been to resist any change requested because of year-to-year fluctuations only. However, alterations in standards are needed as a product's characteristics change because of new methods of production, handling, or processing; or as demands shift in response to changing technology or habits of living; or as practical measures of product characteristics are perfected. Unalterable standards eventually would fail to reflect quality as it is judged in the marketplace and would become useless.

Most grades are developed for wholesale trading and, in general, have not been well suited for use at retail; progress in retail selling by grades has lagged (although some grades, such as for meats and processed fruits and vegetables are developed for both purposes). One important difference is that wholesale buyers frequently must consider how well a product will hold up in transit or storage and thus, for example, would prefer a firm or fairly hard peach, while a consumer likely would prefer a fully ripe one. Also tolerances allowed for defects in wholesale grades generally are greater than desirable for retail trading. When a product is packed in smaller retail-sized containers it is more difficult to keep the contents of each package within a given tolerance. A carload or truckload of eggs, for example, usually contains some variation in quality, and wholesale grades allow for this. However, when packed in cartons of twelve for retail sale, the eggs in each carton must be fairly uniform in quality and must not include any bad ones.

The lack of standardized nomenclature for grades of agricultural products represents a problem, particularly to those unfamiliar with the different commodities. To the uninitiated the complexity of terms used to indicate top quality—such as AA (butter), A (canned fruits and vegetables), No. 1 (grain), Prime (beef), and Fancy (apples)—is confusing. Reasons for this situation are traceable to the terms used in the trade standards that anteceded official standards and the need for adopting these terms to encourage greater use of official standards on a voluntary basis. When official standards are used at retail, however, it is expecting too much to ask consumers to learn an overly complex system of grade names.

A start on this problem, on some commodities, has been made by using the letters AA, A, B, and C in connection with the grade terms that carry through to retail, and also by using letters on grades set up entirely for retail use. This system is simple, but it has met some objection because the terms B and C carry a connotation of being second- and third-rate. The system of grade terms—Prime, Choice, and Good—which is used for beef at wholesale and which has been carried through and widely used at retail, seems free of this connotation, but how much of the popularity of meat grades at retail can be attributed to this selection of terms no one really knows.

One principal contribution the Department of Agriculture has made to national standards, and yet an area in which more needs to be done, is in working out practical objective methods for measuring and classifying product characteristics. Although many objective methods are employed it is still necessary in frequent instances to rely on the subjective judgment of trained inspectors.

Many advances have been made in measuring color through simple color charts and intricate scientific devices; models, sketches, and photographs have been developed to illustrate physical defects and appearances; useful means of measuring length and strength of cotton fibers have been developed; burn tests have been standardized to measure fire holding capacity of cigar leaf tobacco, etc. Nutritional values have been too time-consuming and expensive to use in standards under commercial conditions. It is considered likely (but not in all cases proved) that the factors of color, flavor, total solids, and physical composition, as used in standards for canned and frozen fruits and vegetables, reflect those harvesting and processing practices that also retain a high proportion of the nutritional values. From studies made to date, it appears that some chemical components of tobacco can be correlated with type and grade, but work has not progressed far enough to use chemical tests in the standards. The gluten content of wheat has an important effect on the suitability of flour for commercial bread making, but no measurements, practical for use in grade certification, have been developed as yet.

EXTENT OF USE OF OFFICIAL NATIONAL STANDARDS

Table 17-A shows for each major agricultural commodity or commodity group the approximate percentage sold at farm, wholesale, and retail certified as to grade according to official national standards. Also shown is whether official inspection is done by (1) federal employees, (2) state employees working under federal-state cooperative agreements, or (3) licensed inspectors other than those in the first two groups. The licensed inspectors may be self-employed or work for a trade agency. The fees are those most usually charged. On most commodities they are adjusted according to volume of business. Among commodity groups they differ depending on how much is needed to cover costs of doing the work over the amount appropriated by Congress.

Eighty-four per cent of the 1953 cotton crop was officially graded prior to sale by farmers—78 per cent under the Smith-Doxey Act, and 6 per cent on a fee basis for purposes of putting the cotton under government loan. Farmers receiving the Smith-Doxey service are able to sell according to quality produced, whereas previous to this act the prevailing practice was for buyers to make their purchases on the basis of a single price for all cotton delivered. Cotton mills look primarily to cotton merchants for their supplies, and of their total purchases approximately 75 per cent was described in terms of United States standards—about 70 per cent in terms of these standards as assigned by merchants and 5 per cent as classed by official inspectors.

Official grading of cottonseed and cotton linters normally is done at the request of the oil seed crushing plants. They make nearly all purchases of cottonseed from gins on the basis of official certificates. Official grading of cotton linters is used periodically during the season to check on and control the quality of linters being produced.

Grading of beef according to official national standards was given an impetus when the Office of Price Administration made official grading mandatory during World War II, and again when the Office of Price Stabilization made it mandatory during the Korean conflict. Just prior to World War II, only about 10 per cent of all beef was federally graded. Following World War II, the beef federally graded on a voluntary basis

TABLE 17-A. APPROXIMATE PERCENTAGE OF AGRICULTURAL PRODUCTS CERTIFIED AS TO GRADE ACCORDING TO OFFICIAL NATIONAL STANDARDS BY FEDERAL, FEDERAL-STATE, OR LICENSED INSPECTORS, JULY 1953 TO JUNE 1954.

Commodity	Approximate percent of total sales certified as to grade by official inspectors			Inspectors used[a]	Typical fees charged[b]
	farmer selling	wholesale trading	retail selling		
Cotton	84	5	0	Fed. & lic.	25¢ per sample Free to farmers
Cottonseed	0	90	0	Lic.	$3 to $5 per sample
Cotton linters	0	20	0	Fed. & lic.	20¢ per sample
Beef	0	50	50	Fed.	$3 to $4 per hour
Butter[c]	0	54	6	Fed. & F–S	$10 per carload
Cheddar cheese[c]	0	35	1	Fed. & F–S	$10 per carload
Nonfat dry milk[c]	0	57	1	Fed. & F–S	$30 per carload
Chickens[c]	0	7	1	Fed., F–S, & lic.	$20 for 30,000 lbs.
Turkeys[c]	0	25	10	Fed., F–S, & lic.	$20 for 30,000 lbs.
Shell eggs[c]	0	9	3	Fed., F–S, & lic.	$17.50 for 600 cases
Frozen eggs[c]	0	88	0	Fed., F–S, & lic.	Contract basis
Dried eggs[c]	0	82	0	Fed., F–S, & lic.	Contract basis
Fruits & vegetables for fresh use	8	45	4	Fed. & F–S	$6 to $12 per carload
Fruits & vegetables for processing	40	0	0	Fed. & F–S	$1.50 to $3 per hour
Canned fruits & vegetables	0	20	8	Fed. & F–S	$11.60 for 1000 cases
Frozen fruits & vegetables	0	80	3	Fed. & F–S	$14.75 for 25,000 lbs.
Peanuts	95	0	0	Fed. & F–S	$12 per carload
Grain	15	100	0	Fed. & lic.	$1.50 to $2.50 per carload $1.00 to $1.25 per 1000 bu.
Dry beans	12	50	0	Fed. & lic.	1¢ to 2¢ per bag or 100 lbs.
Dry peas	75	55	0	Fed. & lic.	1¢ to 2¢ per bag or 100 lbs.
Rice	25	65	0	Fed. & lic.	½¢ to 1½¢ per bag or 100 lbs.
Hay	0	2	0	Fed. & lic.	25¢ to 30¢ per ton
Hops	98	98	0	Fed. & lic.	35¢ per bale
Tobacco	95	13	0	Fed.	$3 to $4 per hour (Free on designated markets)
Gum rosin	0	81	0	Fed. & lic.	3¢ to 10¢ per drum
Gum turpentine	0	21	47	Fed. & lic.	4¢ to 8¢ per drum

[a] Fed. designated federal employees; F–S, those working under federal-state cooperative agreements; and lic., licensed inspectors other than those in first two groups.

[b] For most commodities these fees are subject to adjustment according to size of lot and actual costs.

[c] 1953 calendar year data.

leveled off at 25 per cent. Following the Korean conflict voluntary official grading held at about 50 per cent of all meat sold. A number of large chain stores and others have discontinued using trained meat inspectors as buyers and make their purchases on the basis of United States standards. Many retail stores advertise the official grades handled.

Most official inspection of cheddar cheese and nonfat dry milk and about half of all the official inspection of butter was for purposes of selling these products to the government under the price support program or for military use. Of the official grading of butter going into commercial channels, most is done at packaging plants in the midwest producing areas, where it is used as a basis for price settlement with creameries and in selling, and in the terminal markets where it is used to facilitate trading, including spot and futures transactions on the organized exchanges. In a small percentage of butter, cheddar cheese, and nonfat dry milk, the official grades are printed on the retail packages for consumer guidance.

Official grading of poultry is largely grading of ready-to-cook eviscerated birds at dressing plants located in the producing areas, from where the poultry is shipped to consuming markets packed in ice or frozen. On some of the birds, grades are identified by means of a label or metal tag on individual carcasses in such a way as to carry the information through to consumers. Only small amounts of live and "New York dressed" birds are officially graded. Some official grading is done in the terminal markets, where among other things, it is used for wholesale trading and as a basis of settling futures contracts on turkeys and fryers.

Official grading of shell eggs is done mostly at shipping point assembly plants, and includes both wholesale grading and grading of eggs packed in cartons of one dozen each for direct distribution to retail stores. Grading for both purposes also is done in the terminal markets, and official egg grades are used as a basis for spot and futures trading. Inspection of frozen and dried eggs is done largely at the plants packing these products, by means of inspecting the quality of breaking stock used, sanitation in plant, and methods of preparation. There also is a limited amount of inspection for condition of eggs after being frozen or dried.

Most official inspection of fresh fruits and vegetables is done for shippers in the producing areas, usually after the product has been sold by the farmer. On about 4 per cent of fresh fruits and vegetables sold at retail, the products are identified according to grades certified by official inspectors. Many consumer-sized bags marked "U. S. No. 1," and offered for sale at retail, have not been officially inspected.

Approximately 40 per cent of all fruits and vegetables sold by farmers for processing are officially graded at time of delivery. The common practice is for processors to contract with growers for needed supplies in advance, sometimes even before a crop is planted, and to specify in the contract that payment is to be based on the delivered grade.

Plants packing canned and frozen fruits and vegetables frequently request official inspection services for purposes of quality control. The grades assigned may or may not be used as a basis for selling. When sold at retail, about 8 per cent of canned fruits and vegetables and about 3 per cent of frozen fruits and vegetables carry the official grade on the label.

Ninety-five per cent of all peanuts are officially certified as to grade prior to sale by the grower. In 1949, a government price support program caused nearly all peanuts to be officially inspected, and the service was found to have so many advantages both to farmers in selling and dealers in buying that wide-spread voluntary use of federal-state inspection has been continued.

The official grading of grain, dry beans, and rice, prior to sale by farmers, was largely for purposes of putting these commodities under government loan. Official grading of dry peas, however, was used by farmers in commercial selling. The peas usually are officially inspected when delivered to the processor or warehouse for storage. Practically all grain moving to market through commercial channels is officially graded because such grading is mandatory when grain is sold by grade and shipped in interstate or foreign commerce. Occasionally, a few lots, probably less than 0.5 per cent, are sold in interstate or foreign trade on the basis of description or sample only. When dry beans, peas, and rice are exported the usual practice is to have them inspected as a protection against possible disputes regarding quality shipped.

Requests for official inspection of hay are limited. Most trading of this product is on the basis of personal inspection or description.

Ninety-eight per cent of hops is officially inspected for freedom from leaf, stem, and seeds before being sold by growers, and the certificates issued usually stay with each lot through subsequent steps in marketing. Sometimes when a lot is divided, with parts going to different buyers, supplemental certificates are issued to maintain the identity of quality for each part.

Free and mandatory grading of tobacco is provided by the Tobacco Inspection Act on any auction market where a majority of growers vote for the service. Of tobacco produced in the United States, approximately 95 per cent is sold over established auction markets, and in each of these markets the growers have voted for mandatory grading. Tobacco buyers, however, make nearly all their purchases on the basis of personal inspection. The 13 per cent of tobacco purchased in wholesale trading by official grades is primarily sold by farmer-owned cooperatives.

Official grading of gum rosin is done for the most part by licensed inspectors employed by processing plants in about twenty-five locations in the Georgia, Florida, Alabama, and Mississippi producing areas. The certificates of grade are used as a basis for marking the containers and sale of the rosin.

Official inspection of gum turpentine sold in wholesale containers such as large drums, tank cars, or tank steamers is done only periodically as requested by processors, wholesale distributors, or exporters. The certificates indicate that the product meets official specifications for "gum spirits of turpentine." About 47 per cent of gum spirits of turpentine packed for retail distribution in small drums, cans, or bottles is officially inspected, and on the container it is stated that the product is U. S. Government inspected and certified.

BENEFITS OF OFFICIAL NATIONAL STANDARDS

Farmers have long been advocates of national grade standards, and the fact that responsibility for federal standards and grades rests in the Department of Agriculture and that grading services are often conducted under federal-state arrangements is attributable to their interest. Farmers gain from standards of quality as buyers of seeds, feeds, fertilizers, supplies, and equipment. They also gain from national standards applied to products they sell.

With so many farmers engaged in selling, trademarks and brands are of less use to farmers than official grades as means for identifying quality. When sufficient volume is available, farmers may obtain some compensation for sorting and grading their own products, either independently or in cooperation with other farmers. Effective grading in conjunction with efficient communications and transportation services sometimes permits the elimination of handlers and contributes to the more direct movement of farm produce to processors and consumers.

Grades facilitate the payment to farmers on a quality basis. Without grades there is a distinct tendency for higher quality products to be underpriced and lower quality products to be overpriced compared with values established in subsequent stages of marketing. The closer association of price with quality that accompanies grading provides incentive for farmers to produce better quality commodities to meet ultimate market demands. This is particularly important in view of the wide separation between farmers' and consumers' markets, and the fact that intermediary handlers frequently do not transmit market preference information effectively back to farmers. Consequently, standards of quality for agricultural products have a salutary effect in guiding farm production plans.

Market news price reports from competing producing areas and central markets must be related to recognized quality grades in order to be of practical value in making marketing decisions. For example, reporting by grades helps the country shipper better to judge changing price conditions in competing producing areas, and hence the best time for making his sales; it helps him select between alternative markets with greater assurance; and it helps the country shipper who sells on consignment to a terminal market to judge the adequacy of his returns. The reporting of other crop and market information by grades, such as supplies, movement, stocks, and consumption, also is useful. It helps processors and distributors better to anticipate price changes and to plan the flow of products into consumption more intelligently.

Quality grades, along with improved communications and transportation systems, permit buyers in consuming markets to make direct contact with distant producing areas to transact purchases. Sellers are able to start cars of produce rolling to distant markets and negotiate the sales by phone or wire after they are on their way. This ability to obtain a meeting of minds on prices based on quality standards cuts down on the costly practices of maintaining field buyers, or bringing large quantities of products together at central wholesale markets for display and sale on the basis of personal inspection before distributing them to ultimate destination points.

The drawing apart of farm production and the consumers' markets, both geographically and technologically, has been accompanied by growth in size of units processing and distributing farm products to gain advantage of economies of scale. Efficient operation of these units requires precise measurement of quality and greater uniformity in products handled to facilitate the mechanized processing, packaging, and blending functions, and mass distribution of fresh produce through supermarket or chain stores that advertise and price their products on a market-wide basis in metropolitan areas.

The usefulness of quality standards in agriculture is implemented by the federal, state, and private licensed grading and inspection services. These services protect buyers and sellers against misunderstandings or disputes by standing ready to grade the products in accordance with official national standards. They contribute to the validity of contracts by protecting sellers against cancellation of contracts on falling markets because of claimed failure to meet quality specifications. They provide impartial means for measuring extent of damage to product quality resulting from accidents or from negligence by handlers.

The existence of many futures markets is dependent upon the availability of established quality standards and grading services for application to contracts settled by delivery of products. Delivery in fulfillment of futures contracts is usually permitted over a range of established grades with appropriate price adjustments. In a comparable way grades permit forward contracting of many kinds in addition to those formalized on organized exchanges.

Other market functions also are dependent on the availability of grade standards in various parts of the marketing system. Bulk storage of grain, for example, is dependent upon the fungibility of the product so that owners may deposit the grain in elevators where it is commingled with other grain. Because of the grain standards, depositors may have their product graded and expect to obtain equivalent quality at the time of withdrawal. Grade certificates also contribute to arrangements whereby storers of products can obtain loans on those products to finance marketing operations. Banks and other agencies accepting farm products as collateral require reliable grades for these purposes. The pooling of products by numerous farmers for cooperative processing, handling, or shipping is likewise facilitated by grading services that assure participants of commensurate returns for their deliveries.

Nationally standardized and graded products, when available at retail, help consumers to judge relative values more accurately and also to adapt their purchases to appropriate uses, thereby getting more for their money.

To the extent that official national standards contribute toward directing farm resources into remunerative products, reduce the cost of moving these products to consumers, help buyers at each stage of marketing to select qualities best suited to their needs, and broaden market outlets for agricultural products both domestically and overseas, the benefits are shared by all elements of society.

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18. THE ROLE OF FOOD AND DRUG REGULATION

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THE FOOD and Drug Administration enforces laws which "touch phases of the life and health of people, which, in the circumstances of modern industrialism, are largely beyond self-protection."[1]

Congress has repeatedly recognized that the dual purpose of food and drug regulation is to protect the consuming public and provide a climate in which the honest producer can operate without disabling competition from the deliberate chiseler or the producer too careless to furnish clean, safe merchandise.

In a large sense, the Federal Food, Drug, and Cosmetic Act in its entirety is a standard—a broad outline of the high responsibility that must be assumed by those who handle commodities the wholesomeness and integrity of which are essential to public welfare.

Before the first federal food and drug law was enacted in 1906, honest manufacturers had to compete with those who debased their wares and brought public distrust of the whole industry. Merchants selling products of high quality had to do their own inspecting and testing to avoid adulterated and misbranded merchandise. This added to the cost of items so much that only the carriage trade could afford to patronize quality stores. Low-income people were at the mercy of a *caveat emptor* philosophy of business. Today, in contrast, they can find in the supermarkets and the small neighborhood stores throughout the land products as pure as those found in the most expensive stores—with a large proportion of the packaged staple items identical.

Not only the consumer and the businessman benefited but industry was also revolutionized by the federal food and drug law. As the Chairman of the Board of a large food corporation expressed it:

> The conditions created by the passage of the act invited responsible businessmen to put real money into the food business. . . . And the food business began to grow. In the decade between 1900 and 1910, capital investment in

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[1] *U. S. v. Dotterweich,* 320 U. S. 277, 280 (1943).

> food and beverage manufacturing (exclusive of alcoholic drinks) rose from $909,000,000 to $1,700,000,000 and went on growing until today [1946] it exceeds $8,000,000,000.[2] To me these are among the most dramatic industry figures that have ever been spread on the economic record. It is only so, however, when viewed in human terms. For what it meant inevitably was a better life for millions of Americans. It meant more, better, and less expensive food for the consumer; more and better jobs for workers; and it made a tremendous contribution to our national social progress.[3]

At the same meeting, which was in commemoration of the fortieth anniversary of the passage of the 1906 law, the Chairman of the Board of a large pharmaceutical house reported that the total production of the pharmaceutical industry had grown fifteen-fold since 1906. He added: ". . . the passage of the first Federal Pure Food and Drug Law in June, 1906, as well as the Food, Drug and Cosmetic Law of June, 1938, did much to stimulate and encourage scientific research in the pharmaceutical industry. Certainly, it made closer control a necessity and raised manufacturing standards to new high levels."[4]

The Genesis of the Pure Food and Drug Laws

This is not the place for a comprehensive discussion of the organization of the Food and Drug Administration. A brief historical outline, however, may clarify later references. (See Chart 18-1.) When Congress passed the Federal Food and Drugs Act in 1906, it made the Secretary of Agriculture responsible for its enforcement and the Bureau of Chemistry responsible for determining whether foods and drugs are adulterated or misbranded within the meaning of the Act. The Chief Chemist of the Bureau was Harvey W. Wiley, who had crusaded for the statute and was known as Father of the Pure Food Law. In 1927 the regulatory functions of the Bureau were separated from pure and applied chemical research on agricultural products and a new administration was formed. The Food and Drug Administration continued to operate under the Department of Agriculture through the enactment of a stronger law in 1938, and was transferred to the Federal Security Agency in 1940, just when the last of the provisions of the new law went into effect. In 1953, the Federal Security Agency became the Department of Health, Education, and Welfare, the Secretary of which is now the responsible enforcement officer for

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[2] The corresponding figure for 1952 was $12.7 billion and the estimated 1956 figure is between $15 and $16 billion.

[3] Clarence Francis, "The National Food, Drug and Cosmetic Law Instituted by the 1906 Act, Its basic Value to Food Industry," *Food Drug Cosmetic Law Quarterly,* Vol. 1, no. 3 (September 1946), p. 382.

[4] S. DeWitt Clough, "The National Food, Drug and Cosmetic Law Instituted by the 1906 Act, Its basic Value to Drug Industry," *Food Drug Cosmetic Law Quarterly,* Vol. 1, no. 3 (September 1946), p. 390.

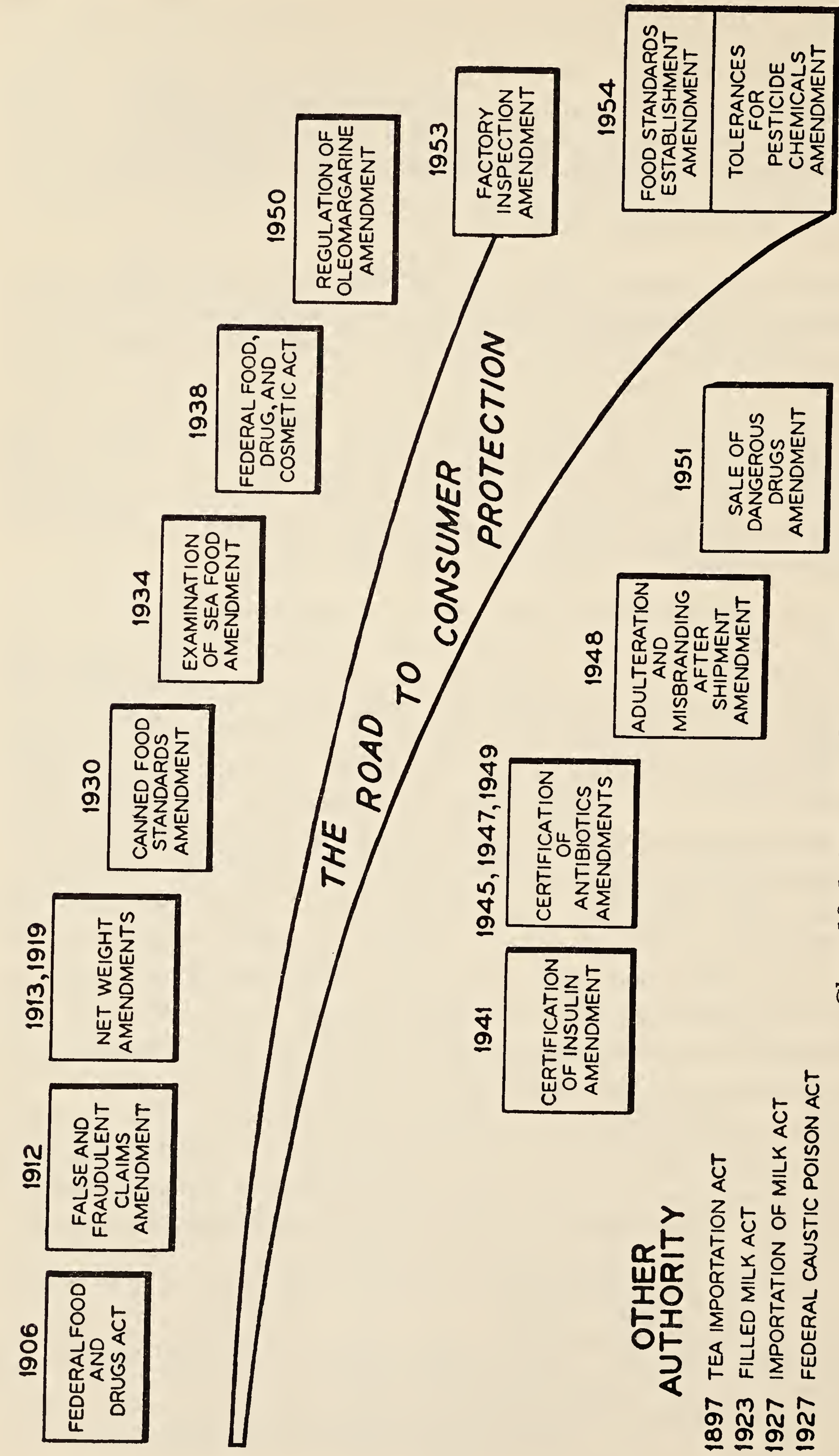
1906
FEDERAL FOOD AND DRUGS ACT
1912
FALSE AND FRAUDULENT CLAIMS AMENDMENT
1913, 1919
NET WEIGHT AMENDMENTS
1930
CANNED FOOD STANDARDS AMENDMENT
1934
EXAMINATION OF SEA FOOD AMENDMENT
1938
FEDERAL FOOD, DRUG, AND COSMETIC ACT
1950
REGULATION OF OLEOMARGARINE AMENDMENT
1953
FACTORY INSPECTION AMENDMENT
1954
FOOD STANDARDS ESTABLISHMENT AMENDMENT
TOLERANCES FOR PESTICIDE CHEMICALS AMENDMENT
THE ROAD TO CONSUMER PROTECTION
1941
CERTIFICATION OF INSULIN AMENDMENT
1945, 1947, 1949
CERTIFICATION OF ANTIBIOTICS AMENDMENTS
1948
ADULTERATION AND MISBRANDING AFTER SHIPMENT AMENDMENT
1951
SALE OF DANGEROUS DRUGS AMENDMENT
OTHER AUTHORITY
1897 TEA IMPORTATION ACT
1923 FILLED MILK ACT
1927 IMPORTATION OF MILK ACT
1927 FEDERAL CAUSTIC POISON ACT

Chart 18–1. Basic Food and Drug Legislation.

the Federal Food, Drug, and Cosmetic Act and several other less comprehensive laws to protect the purity and safety of foods and drugs.

The broad purpose of the law is indicated in the enacting clause: "To prohibit the movement in interstate commerce of adulterated and misbranded foods, drugs, devices, and cosmetics. . . ." The law sets forth certain basic requirements, including freedom from filth or decomposition, preparation and handling under sanitary conditions, packaging in safe containers, use only of certified coal-tar colors, and accurate declaration of the quantity of contents. It requires foods and cosmetics to be free from poisonous or deleterious substances.

For all products there is the "negative requirement" of freedom from false and misleading labeling. For foods and drugs there are certain positive labeling requirements to inform the purchaser as to composition of unstandardized articles, and, when necessary, safe and efficacious use. The law adopts as official for drugs the standards set forth by experts in the medical, pharmacological, and pharmaceutical professions, and directs the Secretary to promulgate food standards and tolerances for poisons, with detailed instructions as to the procedures to be followed.

The definitions and standards for food established according to the provisions of the 1938 Act form the nation's most important cookbook. A large proportion of the fabricated staples on the grocer's shelves today contain the ingredients specified in official food standards.

The first systematic establishment of definitions for food began in 1897 when the Secretary of Agriculture requested the Association of Official Agricultural Chemists to formulate definitions of what should be present in foods most important to consumer welfare. When the 1906 law was enacted, the Secretary used a revision of these definitions as an enforcement guide, since the new law prohibited adulteration and misbranding but made no provision for establishing what the normal composition should be. These advisory definitions had no legal status, and the government soon found that it had to introduce testimony in federal court to prove that undeclared variations were not expected by consumers or sanctioned by good trade practice. Eventually judges and juries brought in conflicting decisions on essentially the same facts, and manufacturers could not be certain of their obligation.

The canners, concerned by the undermining of consumer confidence in all canned foods because of a substantial volume of low-grade, slack-filled products on the market, made the first stride toward quality standards. They sponsored the McNary-Mapes Amendment requiring a substandard label on canned fruits and vegetables falling below the quality and fill prescribed by the Secretary. It passed in 1930 and brought prompt corrections in the limited areas covered. The preservers sought similar protection against inferior products but their proposals had not been enacted when the whole Federal Food and Drugs Act was replaced by the Federal Food, Drug, and Cosmetic Act in 1938. This law introduced an entirely new concept of food standardization.

Food Standards Under the Law

COVERAGE

The general provisions for definitions and standards for foods are contained in Section 401 of the Act:

> Whenever in the judgment of the Secretary such action will promote honesty and fair dealing in the interest of consumers, he shall promulgate regulations fixing and establishing for any food, under its common or usual name so far as practicable, a reasonable definition and standard of identity, a reasonable standard of quality, and/or reasonable standards of fill of container: *Provided,* That no definition and standard of identity and no standard of quality shall be established for fresh or dried fruits, fresh or dried vegetables, or butter [already standardized by statutory definition], except that definitions and standards of identity may be established for avocados, cantaloupes, citrus fruits, and melons. In prescribing any standard of fill of container, the Secretary shall give due consideration to the natural shrinkage in storage and in transit of fresh natural food and to need for the necessary packing and protective material. In the prescribing of any standard of quality for any canned fruit or canned vegetable, consideration shall be given and due allowance made for the differing characteristics of the several varieties of such fruit or vegetable. In prescribing a definition and standard of identity for any food or class of food in which optional ingredients are permitted, the Secretary shall, for the purpose of promoting honesty and fair dealing in the interest of consumers, designate the optional ingredients which shall be named on the label. Any definition and standard of identity prescribed by the Secretary for avocados, cantaloupes, citrus fruits, or melons shall relate only to maturity and to the effects of freezing.

Section 403 spells out the legal status of foods so standardized and Section 701 sets forth the procedures to be followed in establishing the standards. As originally enacted, the Secretary was directed to call a public hearing through a notice stating the proposal in general terms. Any interested person could be heard. The order issuing, amending, or repealing a standard was to be based entirely on substantial evidence received at the hearing, and was to contain findings of fact on which the order was placed. Judicial review by a U. S. circuit court of appeals could be obtained on petition, within ninety days after the order issued, by any person who would be adversely affected by the order.

Of the three types of standards provided—identity, quality, and fill of container—the *definitions and standards of identity* were most needed to stabilize the food situation. They are most important for fabricated foods.

When a housewife buys a product by name, or sends some member of the family to buy it for her, she usually has in mind a specific item. For example, if she asks for mayonnaise, salad dressing will not do, and vice versa. She used to make her own, and not until she could depend on getting as satisfactory a product from the store was she willing to take advantage of the labor saving that would result.

The standards of identity list those ingredients that must be present and those which may be included at the manufacturer's option. No other ingredients may be added; no other foods may be marketed under that name. After the standard goes into effect, the Act declares a food misbranded which fails to comply with the standard established for it.

The only informative labeling statements such products must bear are the name of the food and any optional ingredients required by the standard to be declared. These may, however, give the consumer the only additional information needed to make a satisfactory selection. Among the optional "ingredients" for canned peaches, for example, are whole, half, or sliced peaches, and packing media varying from water to extra heavy peach juice sirup.

The *quality standard* for these peaches relates to tenderness, adequate peeling, uniformity of pieces, and the like. There are no grade designations provided in the Act, such as the Fancy or Grade A used under industry or U. S. Department of Agriculture grading systems, but if lower grade peaches were described Fancy or Grade A on the label, the product would be misbranded under the Act. Quality standards require that a product meet the satisfactory standard outlined or be labeled "Substandard," and in some cases, the reason for failure to meet the standard may be given, such as "not well peeled, unevenly trimmed."

These and the similar provisions under the McNary-Mapes Amendment have virtually driven substandard items off the market after the adoption of quality standards for a particular product. Dealers and consumers alike shy away from foods bearing the "crepe label," as the industry calls it, since the substandard legend must be enclosed in a black border. Such food, however, is wholesome and entirely suitable for some uses.

Fill of container standards, in general, require packages to contain the maximum quantity of food that can be sealed in the container and processed without damaging the food.

A Food Standards Committee was appointed by the Secretary in August 1938 to facilitate standard-making operations. It was composed of four experienced state food-law enforcement officials and two representatives of the Food and Drug Administration. This committee, in cooperation with administrative officers, began immediately to determine which foods should be standardized, and the analytical and inspectional data required to formulate the standards.

FDA inspectors investigated trade practices, consumer and industry views. The chemists prepared authentic packs, reviewed cookbooks, checked the analytical methods available to establish deviations from proposed standards, and began to develop better ones where needed.

The Committee considered the data thus acquired, consulted with home economists and other experts, and formulated proposals for the hearings which began in January 1939.

"Enriched" Foods

As the standards program developed, the question soon arose as to what extent variations of staple foods should be permitted in the best interest of the public. The first problem was fortification with vitamins and minerals. Keen competition had grown up in attempts to attract the consumer by extolling the nutritional benefits of various types of food "enrichment," some well-founded and others completely irrational. Reports of surveys in this country showed diet deficiencies that needed correction, but with all of the claims for various kinds and degrees of enrichment offered, it was an exceptionally well-informed consumer who could make an intelligent choice.

After receiving recommendations of the leading nutritionists, the Administrator established the basic policy in regard to fortification of standardized foods: fortification would be restricted to those products which required it to help correct deficiencies in the diet of a substantial proportion of the population; a minimum and a maximum fortification would be established, the former to meet the need and the latter to mark the point above which the addition of vitamins and minerals would serve no nutritional purpose but would be only an opportunity for trade "puffery" and consumer confusion. Usually the foods officially selected for fortification were those that had lost essential nutrients during refining or other processing, white flour, for example, or foods particularly well adapted for the widespread distribution of essential nutrients, such as milk to which vitamin D is added.

The standards recognized plain foods and enriched foods, with no middle ground, a position the Supreme Court endorsed when it held that farina enriched with vitamin D and so labeled, but without the other enriching factors required for "enriched farina," did not conform to the standards of either product. The Court said that the purpose of identity standards was to "reflect a recognition by Congress of the inability of consumers in some cases to determine, solely on a basis of informative labeling, the relative merits of a variety of products superficially resembling each other."

Chemical Additives

Commercial processing of food has introduced new methods and new ingredients little known to the housewife—softeners, hardeners, antioxidants, emulsifiers, and the like. Some of them improve the quality of the finished product and others cheapen it without making it evident to the casual observer. Some are known to be safe and will cause the consumer no detriment if they are not used to conceal inferiority.

The question of the safety of optional ingredients proposed for inclusion in standards of identity for food was largely a postwar development. Hearings had been held and a tentative order issued for certain types of bread in 1943; then the War Food Administrator requested that the final order be postponed until after the war because of potential disruptions in the war food economy. When the hearing was reopened in 1948, to receive additional evidence before the final order was issued, proposals were introduced by industry representatives that substances that had come into widespread commercial use in the interim be listed as optional ingredients. Included were polyoxyethelene "softeners" still under investigation by pharmacologists because their safety for longtime use was suspect, particularly in view of their close chemical relationship to compounds known to be toxic.

After prolonged hearings, largely concentrated on such issues, the Administrator refused to permit the additives to be listed as optional ingredients, a decision in which he was upheld by the appellate court, which said: "One making a rule for the future which in practical effect will determine whether millions of people shall eat something every day may reasonably refuse to subject the general public to even slight risks. . . ."

Poisonous Substances in Foods

Another regulatory program of the Food and Drug Administration depending on the establishment of safety standards, is control of the addition of poisonous or deleterious substances to foods. Section 406 (a) of the Act states:

> Any poisonous or deleterious substance added to any food, except where such substance is required in the production thereof or cannot be avoided by good manufacturing practice shall be deemed to be unsafe for purposes of the application of clause (2) of Section 402 (a); but when such substance is so required or cannot be so avoided, the Secretary shall promulgate regulations limiting the quantity therein or thereon to such extent as he finds necessary for the protection of public health, and any quantity exceeding the limits so fixed shall also be deemed to be unsafe for purposes of the application of clause (2) of Section 402 (a). While such a regulation is in effect limiting the

quantity of any such substance in the case of any food, such food shall not, by reason of bearing or containing any added amount of such substance, be considered to be adulterated within the meaning of clause (1) of section 402 (a). In determining the quantity of such added substance to be tolerated in or on different articles of food the Secretary shall take into account the extent to which the use of such substance is required or cannot be avoided in the production of each such article, and the other ways in which the consumer may be affected by the same or other poisonous or deleterious substances.

Hearings were specified similar to those for establishing food standards. The first held were on pesticides that remain as residues on agricultural crops. Experience proved that the process was too cumbersome to serve the public interest and in July 1954 the law was amended to change these procedures. The amendment provides for a determination by the Secretary of Agriculture of whether the pesticide is useful in the production of food crops, and the promulgation by the Secretary of Health, Education, and Welfare of safe tolerances for residues retained by the foods, after the review of toxicity tests conducted by the manufacturers and such other investigations as may be in the public interest. Proposals for tolerances may be reviewed by an impartial committee of scientific experts, at the request of anyone affected by the proposed limitation, or of the Secretary if such review is deemed desirable.

Congress stipulated that these activities should be supported by fees paid by those requesting official tolerances for new pesticides, or by those who, by filing objections, require further consideration through either review by the committee of experts or public hearings. The first application under the new procedures was received in December 1954. In the following 18 months, the status of about 100 pesticidal chemicals was established for one or more uses on crops.

Dietetic Foods

A bridge between the standards defining the foods that form the staples of the American diet, whether or not enriched with vitamins and minerals, and the drugs that are needed in times of illness, is the foods that must be of special composition for the control of disease conditions. For such foods, standards of measurement may be vitally essential.

The measurement of sugar content and its declaration on foods for special dietary use became clearly defined many years ago because of the recognition of its importance in the dietary control of diabetes. In relation to the low-sodium foods the situation was more confused. In general, low-sodium diets are newer, and at first many manufacturers of such foods, and housewives attempting to provide low-sodium diets partly from home-cooked foods, were not aware of the sources of sodium in products designed to leaven baked items, shorten the cooking time of cereals, process hominy and peeled fruits, stabilize ice cream and chocolate drinks, retard molding in bread and cheese, and serve other functions adapted to commercial processing.

Regulations were published in 1954 to require labeling of purportedly low-sodium foods in terms of milligrams per 100 grams and for each average serving in measured amounts, such as a half cup or a designated number of wafers. Studies to re-evaluate the normal sodium content of the most commonly used foods, undertaken jointly by appropriate committees of the National Research Council, the American Medical Association, and the Food and Drug Administration, were published shortly afterwards.

PROCEDURES

One of the most serious problems apparent after a number of protracted hearings, was that the food standards process had become too long and costly to serve the public interest. Recommendations to correct the situation have been made by numerous scientific and legal experts. They have suggested that the hearings could be expedited by deciding the safety of new chemical additives by some more appropriate means; issuing standards without hearings when no controversy arises; better informal liaison between the government and industry before standards are formulated; and broadening the scope of temporary permits to allow processors to make market tests of new food products that vary in composition from that permitted in the official standards.

Progress has been made on all but the first of these recommendations, and it still depends upon legislative enactment.

The Hale Amendment, passed in April 1954 without opposition, simplified the standards-making procedures to the extent that hearings are required only when objections are filed to proposals published by the Secretary, and then only on the points in controversy. The provision for appellate court review was retained.

The conditions under which temporary permits may be issued to make a market test of foods differing from the standards were given greater latitude through a regulatory order of the Secretary in April 1954. Through these permits the Secretary exempts food from compliance with certain provisions of the standards while the manufacturer tests public acceptance of the changed product, thus permitting improvements and preventing static standards. Prior to this time temporary permits were restricted to the addition of new ingredients. Under the new regulations, a required ingredient may be omitted or other changes made that might improve the product and be advantageous to the consumer.

Administrative steps have been taken to bring about closer cooperation during the formative stages of food standards amendments, particularly among scientific experts representing all interests concerned, who can find many areas of agreement in the technical aspects involved.

The final stumbling block on the road to prompt enactment of food standards has been decreasing enforcement resources in the Food and Drug Administration to do the field and laboratory work required as a basis for sound, fair, workable standards, and to provide the counsel and scientific experts to carry this data through the formulation, hearing (if required), and review stages necessary for recommendations to the Secretary.

ENFORCEMENT

On the enforcement side, diminished funds to control economic violations have meant fewer inspectors to check watered oysters, hard peas, low-fat dairy products, substandard fill, and other standards violations. Where the producers have wanted to take advantage of the lower degree of regulatory coverage, this has been a burden on the consumer, and also on the merchant who buys and sells his wares in good faith. Inadequate enforcement places the honest producer in an unfair competitive position —exactly what the "pure food laws" were intended to prevent. The President recommended a substantial appropriation increase to strengthen enforcement facilities, when he submitted the 1957 budget to Congress.

Drug Standards Under the Law

The Federal Food, Drug, and Cosmetic Act of 1938 recognizes *The Pharmacopeia of the United States of America, The National Formulary,* and *The Homoeopathic Pharmacopoeia of the United States* as official compendia for drugs. Drugs sold under the names recognized in these volumes must comply with the specifications outlined or state in what ways they differ; otherwise they violate the misbranding provisions of the law.

The first two compendia became a part of the law of the land in 1906. They were recognized authorities for establishing uniformity of drugs when Wiley began his crusade for a national food and drug law, but the standards had been voluntary in some states and enforced only on a local basis in others. The method of formulating these standards is described elsewhere in this volume.

The composition of drugs not defined in the official compendia must be described on their labels giving the common and usual name of each constituent part. When drugs are composed of two or more ingredients the name and quantity or proportion of each active ingredient must be stated. Label statements are required also of the presence of certain ingredients, such as alcohol and bromides, that might affect the welfare of the patient. Warnings of habit-forming properties are required for narcotic and hypnotic drugs, and adequate directions must be given for drugs that are to be self-administered. Those not suitable or safe for self-administration must bear the legend "Caution: Federal law prohibits dispensing without prescription." In recent years a large percentage of the Food and Drug Administration's prosecutions under the drug provisions of the law have been cases of unauthorized sales of prescription drugs by the small proportion of pharmacists who do not comply with this measure designed to protect the public against the misuse of dangerous drugs.

CONTROL OF NEW DRUGS

The new-drug section of the Act provides that no new drug shall be introduced in interstate commerce unless an application has been filed with the Secretary establishing that it is safe for use. The evaluation of the manufacturer's evidence of safety, submitted with the application, is one of the most serious responsibilities of the Food and Drug Administration. The evaluation often does not end with the initial marketing of the drug. Up to this time the preparation has been produced in small quantities and restricted to the use of investigators qualified to perform the scientific testing necessary to establish its safety. If it is widely accepted by the medical profession, a whole series of supplemental applications may be submitted as a result of expansion and improvement of manufacturing facilities and experience in widespread use which may require labeling changes. This work began just at the inception of a new era of drug therapy. All of the sulfonamides, with the exception of sulfanilamide, all of the antibiotics, cortisone, and a large proportion of the other potent drugs used by the physician today, have been introduced under the safety provisions of the new-drug section of the law.

CERTIFICATION SERVICES

The Food and Drug Administration is also charged with a number of certification services based on the establishment of standards, and tests for and certification of compliance. The 1938 Act prohibited the use of coal-tar colors in foods, drugs, and cosmetics unless they are from batches certified by the Food and Drug Administration as safe and suitable for use.

A list of certifiable colors was published in May 1939 following public hearings. The enforcement of the coal-tar color provisions has operated smoothly with the few prosecution cases generally involving use of uncertified or uncertifiable colors in lotions, creams, and other cosmetic preparations. Toxicological re-evaluation of some of the colors originally listed, however, resulted in recent evidence that three of these colors (one red and two orange) are capable of causing serious injury to animals on long-time use in small concentrations, although these concentrations are greater than those ordinarily found in food. A hearing was held in January 1954 to remove these colors from the certifiable list. In November 1955 an order was issued removing them from the list of colors that could be certified as safe for use in foods, drugs, and cosmetics, and adding them to the listing for use in coloring externally applied drugs and cosmetics only. A stay was ordered with respect to the use of one of these dyes for coloring the outer skin of oranges pending an appellate court review of the order.

Two types of drugs are under certification control. In 1941 insulin was placed under certification control just before the patents under which it had previously been controlled were to expire. Certification of antibiotics began in 1945, just before the expiration of War Production Board regulations under which the limited supplies available had been tested by FDA during the war. Streptomycin was added to the list in 1947, and Aureomycin (chlortetracycline), bacitracin, and chloramphenicol in 1949. Tetracycline was added in 1953 by regulation, because of its derivation from chlortetracycline.

Standards of composition and testing of these certified drugs are established by regulation after evaluation of the data submitted by the manufacturer, whatever FDA tests are required, and consultation with the industry scientists who are responsible for factory controls and have full knowledge of the history of the product. This type of standards maintenance keeps fly-by-night concerns from entering a field in which they are unable to produce dependable drugs.

Cosmetic Standards Under the Law

There are no standards for cosmetics beyond those mentioned early in this essay for all products coming within the jurisdiction of the Federal Food, Drug, and Cosmetic Act. In general, the principal problem for the Food and Drug Administration has been to watch the new chemicals that may be introduced, and take action against those likely to cause trouble to the users in general, in contrast to the allergic individual. The law does not require ingredient disclosure on the label, but if the ingredients are mentioned it must be done without creating a misleading impression.

Protection of the Consumer

All of the standards enforced by the Food and Drug Administration, whether specific or general, are for the benefit of the consumer. Often the consumer does not understand the technical language in which they are set forth or the scientific findings which indicate the need for them in the first place. He can be assured, however, that the legitimate manufacturer knows the rules and is complying with them, and that those who break them are guilty of criminal violation of the law. When the law breakers face judge and jury, who, like the consumer, often do not have the technical background to determine what standard would be in the best interest of the public, they cannot rely on confusing the issue. The law enforcement official needs only point out to the court the legal standard and how it was violated. Public protection can from then on be maintained on objective determination of the facts.

These standards are the tools for the maintenance of the integrity of products during scarcities, such as those requiring rationing and strategic material controls during World War II. When other ingredients had to be substituted for those normally used in foods or drugs, the label-reading consumer still knew what he was buying. This protection against "ersatz" products was an important factor in the morale of consumer and producer alike, in contrast to the situation which developed in many other countries during this period, where adulteration was condoned or in some cases ordered.

The future of public protection under food and drug laws depends on continued amendments to both federal and state statutes to keep them effective instruments to cope with changing times, and on the provision of adequate means of effective enforcement.

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19. NATIONAL STANDARDS IN PHARMACEUTICALS

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AS LONG as there have been the roles of physician and apothecary-pharmacist, one prescribing and the other dispensing medicines, there have been compendia describing the articles used as medicines. These treatises have described the genuine drugs and the best methods of preparing effective and satisfying medications. Part of the early history of drugs is fable and part is imperfect translation. From the Renaissance, however, these professions have been trying in their best scientific manner to fix standards to unify practice in the use of drugs.

The importance of standardization became so well recognized that gradually, by charter, by ordinance, by imperial edict, and finally by legislative enactment, the civilized world was given authoritative works, often having the force of law, which assigned definitive titles to drugs and provided standards of identity, strength, quality, and purity for those commonly used as medicine. Whether prepared by governmental commissions or by otherwise constituted groups of specialists, each compendium represented the best judgment of the two professions.

Three styles of compendia are devoted to the description of drugs. All contain technical specifications for drugs and medicines. The professional character and legal weight of these various compendia are often misunderstood by laymen.

A *pharmacopeia*[1] describes drugs, chemicals, and medicinal preparations, and is generally issued by authority and used as a standard.

A *formulary* is a work that contains a list of medicinal substances and formulas for making medicinal preparations.

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[1] The use of the diphthong "œ" in the spelling of pharmacopoeia is classical. The U. S. P. Convention of 1940 voted to discontinue its use and to substitute the letter "e" for the diphthong, except as it affected the corporate title of the convention. We do not use the diphthong in this discussion, but the use of the letters "oe" indicates that the diphthong was used in the published text from which we quote.

A *dispensatory* is a book giving a systematic description of drugs that are of medical value.

The real history of pharmacopeia-making begins with medical members of the Florentine guild of physicians and apothecaries who, in 1498, constituted a commission organized at the request and with the support of pharmacists. Their report was entitled "Nuovo receptario composito" and its use was obligatory for Florentine apothecaries. While the status of this work as a handbook to guide two professional groups did not constitute government sanction, it required that medicinals be prepared according to a standard procedure. It is not possible to include here a bibliography of pharmacopeias,[2] but we must at least mention the *Dispensatorium* of Valerius Cordus, published in Nürnburg in 1546; the *Dispensatorium Augsburgense* of 1564; the *Pharmacopoeia Augustana*, which became standard for Vienna and the Austrian provinces in 1613; the *Pharmacopoeia Londinensis* of 1618; the formulary of the College of Physicians of Lyons of 1628; and the *Pharmacopoeia Edinburgensis* of 1699. The influence of the London and Edinburgh pharmacopeias was strong in the American colonies. During the war for independence the military hospitals of the continental army were under the direction of both a surgeon general and an apothecary general, and for the use of the hospitals at Lititz and Bethlehem, in Pennsylvania, there was published on March 12, 1778, the *Pharmacopoeia simpliciorum et efficaciorum*.

The history of drug standardization in the United States continues with *The Pharmacopoeia of the Massachusetts Medical Society*, prepared by a committee appointed to draft a volume adapted to the special wants of the New England area. The committeemen did their best to make the work national by trying to secure, though with little success, the cooperation of medical groups in other states. This volume came from the press in 1808 and followed the style of the Pharmacopoeia Edinburgensis, although containing much original material relating to native drugs. A third American pharmacopeia was edited by a committee of the staff of the New York Hospital and published in 1816.

Origin of the United States Pharmacopeia

Although the New York, like the Massachusetts, pharmacopeia enjoyed more than a local reputation and usage, it was felt that so important a compendium should be broadly based; and in January 1817 Dr. Lyman Spalding submitted to the New York County Medical Society a project for the establishment of a national pharmacopeia. Spalding proposed that the United States be divided into four districts, each of which should hold a subconvention of the medical colleges therein and prepare a draft of a pharmacopeia. These drafts would then be taken to a national convention to be held in Washington, where a national pharmacopeia would be compiled. When that convention assembled in 1820, the chairman chosen was Samuel L. Mitchill, the senior author of the pharmacopeia of the New York Hospital. The gathering took the name The United States Pharmacopoeial Convention, appointed a publication committee, with Dr. Spalding as Chairman, having authority to issue the pharmacopeia, and provided for the calling of a second convention of 1830. The U. S. Pharmacopeia[3] was published in 1820.

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[2] For a comprehensive history of pharmacopeias, see Edward Kremers and George Urdang, *History of Pharmacy*, 2nd ed. (Philadelphia: J. B. Lippincott Company, 1951).

The first two paragraphs of the preface to this first U. S. Pharmacopeia set forth what may be called the platform of the U.S.P. Convention, which has been scrupulously followed by each committee of revision from that time:

> It is the object of a Pharmacopoeia to select from among substances which possess medicinal power, those, the utility of which is most fully established and best understood; and to form from them preparations and compositions, in which their powers may be exerted to the greatest advantage. It should likewise distinguish those articles by convenient and definite names, such as may prevent trouble or uncertainty in the intercourse of physicians and apothecaries.
>
> The value of a Pharmacopoeia depends upon the fidelity with which it conforms to the best state of medical knowledge of the day. Its usefulness depends upon the sanction it receives from the medical community and the public; and the extent to which it governs the language and practice of those for whose use it is intended.[4]

The first U. S. Pharmacopeia began with two lists of drugs totaling thirty pages, arranged alphabetically by the Latin titles. The committee explained the arrangement into two lists in this wise:

> the number of simples occasionally employed in practice is much greater than it suits the proper compass of a Pharmacopoeia to contain. . . . With a view of discriminating between articles of decided reputation or general use, and those, the claims of which are of a more uncertain kind; the Convention determined to refer to a secondary list such substances as were deemed of secondary

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[3] "Prior to the first U.S.P. there was, in America, no authoritative list of approved medicinal agents, and no generally accepted system of drug nomenclature. Widely different drugs and preparations were often designated by very similar names, while sometimes the same drug was known by several different names, and consequently, there was no assurance that an article supplied on prescription would be the same as that intended by the prescriber, or something of very different composition and potency." J. H. Beal, "Character and Purpose of the United States Pharmacopoeia," *Journal of the American Pharmaceutical Association,* Vol. 19 (November 1930), p. 1215.

[4] *The Pharmocopoeia of the United States of America* (Boston: Printed by Wells and Lilly for Charles Ewer, 1820), preface, p. 3.

or doubtful efficacy, retaining only on the principal list articles which might be considered of standard character.[5]

The formulary section, of 203 pages, contained directions for preparing medicines in common use, and for the manufacture or purification of medicinal chemicals, as this country had no manufacturing chemical industry. The formulary was printed in parallel pages of English and Latin so that the text might be usable where English was not the mother tongue. The use of a Latin text was soon abandoned, but the official titles of drugs and medicines were arranged alphabetically in Latin, followed by their English equivalents, through the twelfth revision, published in 1942, in homage to the vain belief that Latin was the universal and unvarying language of science.

The convention of 1820 and those of 1830 and 1840 were composed entirely of physicians. The committees of revision of the 1830 and 1840 editions were so much beholden to pharmacists for their assistance, especially the members of the Philadelphia College of Pharmacy, that incorporated colleges of pharmacy were invited to send delegates to the 1850 convention and participate in the revision program. From that time the U. S. Pharmacopeia has been the property of pharmacy and of medicine, the pharmaceutical profession having the major concern with problems of revision other than scope, and furnishing the greater market for its sale.

The product of the convention of 1820 was named *The Pharmacopoeia of the United States of America.* Each succeeding decennial convention has authorized a revision, which has been numbered as a revision, beginning with the *First Decennial Revision* in 1830. The convention of 1940, recognizing the need for more frequent revisions and a general review of all standards, instructed its revision committee to adopt a five-year program of revision. To do so required the issue of three pharmacopeias in that decade, with U.S.P. XII becoming official on November 1, 1942; U.S.P. XIII on April 1, 1947; and U.S.P. XIV on November 1, 1950. U.S.P. XV, the first of the two authorized by the 1950 convention, became official on December 15, 1955.

The United States Pharmacopoeial Convention is incorporated in the District of Columbia, and its stated meetings are held in Washington, D. C., on the second Tuesday in April in the year of each decade ending in zero. The constitution of the convention allows one delegate and one alternate from each accredited medical school, accredited school of pharmacy, and from each medical association and pharmaceutical association representing a state, a territory, and the District of Columbia, from the appropriate national professional associations, and the federal services, including the armed forces, that are concerned with the protection of health.

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[5] *Ibid.*, p. 21.

In the interim between the sessions of the convention, its business affairs, including fixing official dates for enforcement of revisions and interim revisions, are entrusted to a board of trustees elected by the convention, which board can fill vacancies in its membership.

THE NATIONAL FORMULARY

Whenever the U. S. Pharmacopeia is named as a legal compendium of drug standards, reference is made at the same time to *The National Formulary*. This compendium, equal under law with the Pharmacopeia, is the copyrighted property of the American Pharmaceutical Association, under whose auspices it is revised and published. In 1851 great concern was expressed about the quantity of adulterated drugs produced in the United States and imported from abroad. A call was accordingly issued for interested persons to gather and form a national association to improve the standards of pharmaceutical practice. Organization in 1852 of the American Pharmaceutical Association resulted. The first stated objective of the Association was "To improve and regulate the drug market by preventing the importation of inferior, adulterated, or deteriorated drugs and by detecting and exposing home adulterations."

This new association put all of its force behind the U.S. Pharmacopeia, which would have been abandoned in 1870 but for the association's interest. The Pharmacopeia gives recognition only to those drugs believed by foremost medical authorites to possess the greatest worth. Since other useful drugs and preparations were prescribed by reputable physicians as well, the association began to plan for a supplementary book of standard formulas, and in 1888 published the first edition of the National Formulary. This compendium was devoted to the formulas of the widely used dosage forms of the time, such as elixirs, emulsions, tinctures, syrups, and pills. Although it was at first, as the name indicated, merely a formulary, it became a legal standard in 1906, by which time it was providing standards for many useful drugs which, while not official in the U.S.P., were widely prescribed. It also provided standards for many items of pharmaceutical necessity. Each issue of the National Formulary is regarded as a new edition, rather than a revision, as in the case of the U.S.P. Colloquially, these books are better known throughout the industry and the professions by their initials than by their full names.

THE HOMOEOPATHIC PHARMACOPOEIA OF THE UNITED STATES

The Homoeopathic Pharmacopoeia of the United States furnishes directions for the selection and preparation of remedies which are thoroughly adapted to the purposes of homoeopathic practice, a system of medical practice organized in the belief in a theory that disease is cured by remedies which produce on a healthy person effects similar to the symptoms of the complaint of the patient, the remedies being usually administered in minute doses. The borderline between homoeopathy and allopathy (the "regular" school of medicine) is much less distinct at this time, but there is retained a preference for drugs of natural origin rather than synthetics, and a continuing belief in the greater activity of medications administered in considerable dilution.

The Homoeopathic Pharmacopoeia is revised and published by a committee of the American Institute of Homoeopathy and is currently official as the Fifth Edition. Except where the drug as originally "proved" by some distinguished homoeopath had some peculiar characteristics resulting from its origin (calcium carbonate, for example, is prepared by calcining oyster shells), or the medicinal preparation made from the fresh drug, a drug which satisfied the requirements of the U.S.P. or the N.F. would suffice as the basis for an official preparation. The Homoeopathic Pharmacopoeia does not provide many critical tests for identity and purity of drugs, and contains few assays, and except for its status as a compendium of preparations standardized by their method of manufacture, might more properly be called a dispensatory.

THE OFFICIAL STATUS OF DRUG STANDARDS

Prior to 1906 the authority of the U. S. Pharmacopeia and the National Formulary was moral rather than actual, although they were referred to as standards for the quality and purity of drugs in various state laws. But the first Federal Food and Drugs Act, of June 30, 1906, made reference to the U.S.P. in the following words:

> the term "drug" as used in this Act, shall include all medicines and preparations recognized in the United States Pharmacopoeia or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of either man or other animals.
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> . . . for the purposes of this Act an article shall be deemed to be adulterated: In case of drugs: First. If, when a drug is sold under or by a name recognized in the United States Pharmacopoeia or National Formulary, it differs from the standard of strength, quality, or purity, as determined by the test laid down in the United States Pharmacopoeia or National Formulary official at the time of investigation: *Provided,* That no drug defined in the United States Pharmacopoeia or National Formulary shall be deemed to be adulterated under this provision if the standard of strength, quality, or purity be plainly stated upon the bottle, box, or other container thereof although the standard may differ from that determined by the test laid down in the United States Pharmacopoeia or National Formulary.

Public Law No. 717 of the 75th Congress is entitled, "An Act to prohibit the movement in interstate commerce of adulterated and misbranded foods, drugs, devices, and cosmetics . . ." and is cited by the short title "Federal Food, Drug, and Cosmetic Act." This act more extensively defines the authority of the Pharmacopeia, and the other compendia thus:

> The term "drug" means (1) articles recognized in the official United States Pharmacopoeia, official Homoeopathic Pharmacopoeia of the United States, or official National Formulary, or any supplement to any of them. . . .
>
> The term "official compendium" means the official United States Pharmacopoeia, official Homoeopathic Pharmacopoeia of the United States, official National Formulary, or any supplement to any of them. . . .
>
> A drug . . . shall be deemed to be adulterated . . . if it purports to be or is represented as a drug the name of which is recognized in an official compendium, and its strength differs from, or its quality or purity falls below, the standard set forth in such compendium. Such determination as to strength, quality, or purity shall be made in accordance with the tests or methods of assay set forth in such compendium. . . . No drug defined in an official compendium shall be deemed to be adulterated under this paragraph because it differs from the standard of strength, quality, or purity therefor set forth in such compendium, if its difference in strength, quality or purity from such standard is plainly stated on its label. . . . Whenever a drug is recognized in both the United States Pharmacopoeia and the Homoeopathic Pharmacopoeia of the United States it shall be subject to the requirements of the United States Pharmacopoeia unless it is labeled and offered for sale as a homoeopathic drug, in which case it shall be subject to the provisions of the Homoeopathic Pharmacopoeia of the United States and not to those of the United States Pharmacopoeia.

The net result of the Federal Food and Drugs Act of 1906 and its legislative successor, the Federal Food, Drug, and Cosmetic Act of 1938 is to give official sanction to the standards of the United States Pharmacopeia, the National Formulary, and the Homoeopathic Pharmacopoeia of the United States; not only to those standards official at the time of enactment of either law, but also to those standards which may be revised, devised, and promulgated in the future. If this were delegation of legislative authority by the Congress, or by the legislatures of the several states in enacting their state drug laws, it could well fail to stand in the light of the various constitutional provisions intended to preserve legislative powers. The latest attack on the legality of the Pharmacopeia was made in Wisconsin, where the definition of a drug as an article named in an official compendium had been relied upon by the State Board of Pharmacy in an effort to restrict the sale of medicinal preparations to drugstores. The court was asked if it was appropriate on constitutional grounds for any legislative body to depend upon the standards of the U. S. Pharmacopeia or its sister compendium, the National Formulary.

The Appellate Court held against the Board of Pharmacy, and the Attorney General appealed to the state supreme court,[6] with counsel for the U.S.P. Board of Trustees *amicus curiae.* The State Supreme Court reversed the lower court, saying in substance that it has consistently been held that the legislature may not delegate its power to make a law, but it may delegate those of its powers which are not legislative but which are concerned with setting up the basis on which execution of the law must depend. The court made reference to a Pennsylvania decision of 1873 in which it was said:

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[6] *State v. Wakeen*, 263 Wis. 401, 57 N.W. (2d) 364 (1952).

> The legislature cannot delegate its power to make a law; but it can make a law to delegate a power to determine some fact or state of things upon which the law makes, or intends to make, its own action depend. To deny this would be to stop the wheels of government. There are many things upon which wise and useful legislation must depend, which cannot be known to the law-making power, and must, therefore, be a subject of inquiry and determination outside of the halls of legislation.[7]

A most important exemption is stated in the Federal Food, Drug, and Cosmetic Act in these words:

> No drug defined in an official compendium shall be deemed to be adulterated under this paragraph because it differs from the standard of strength, quality, or purity therefor set forth in such compendium, if its difference in strength, quality, or purity from such standard is plainly stated on its label.

The paragraph just quoted, the "variation clause," appears in substantially the same form in both the old and the new act. U.S.P. XV and N.F. X, both of which became official in 1955, together contain standards for more than 1500 items for medicinal use, of which 60 per cent are drugs in their own right or substances necessary in preparing these drugs for medicinal use. However, one-third of these pharmaceuticals have other uses; they include industrial chemicals, chemical reagents, dyes, soaps, fats, fertilizers, foods and condiments. Except for this clause, every lot of any of these substances manufactured, transported or sold in interstate commerce in the United States would be required to conform to its U.S.P. or N.F. standard regardless of its intended use.

The Mechanism of Pharmacopeial Revision

The responsibility for revision of the Pharmacopeia, including the determination of its scope, lies with the committee of revision, elected by the convention. The chairman of this committee, the Director of Pharmacopeial Revision, is elected by the trustees prior to the assembly of the convention, and is a nonvoting member of the committee and of the board. The revision committee has sixty members, and is organized into ten subcommittees, whose chairmen, together with the secretary of the revision committee, constitute its executive body. The president of the convention, always a physician, is ex officio a member of the committee of revision with voting privileges. Twenty members of the committee must be qualified in the medical sciences, and forty in pharmaceutical and allied sciences, these members being elected from nominees selected during the preceding year with a view to providing the kinds of talent needed.

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[7] *Locke's Appeal,* 72 Pa. 491, 13 Am. Rep. 716, 722 (1873).

THE TASK-FORCES OF THE PHARMACOPEIA

Of the ten subcommittees responsible for revising the Pharmacopeia, by far the most important is that dealing with scope. By custom the subcommittee on scope includes all medical representatives on the committee, including ex officio the president of the convention. Also by agreement all decisions of this group are final unless overridden by vote of two-thirds of the entire revision committee. This subcommittee makes its selections with a view to providing definite standards of strength, quality, and purity for those drugs which represent the best practice and teaching of medicine. The drugs are rated as essential, valuable (but not essential), obsolete, or indeterminate (meaning that the drug might be on its way into or out of favor). All drugs in the previous revision of the Pharmacopeia are so rated, as are the other drugs which come within the ken of the members as specialists. In some cases *ad hoc* advisory panels of specialists from without the committee have been created to consider more unusual problems of medication. Several other members who are specialists in pharmacy also serve this subcommittee with voting powers. Their major responsibilities are to determine the best dosage form of a drug, to recommend its more stable compounds, and to advise about the pharmaceutical necessities that must be given recognition.

The subcommittee on posology, or the science of the dosage and use of drugs, is also selected from those members who represent medical science. Its members speak with authority on the action of drugs on the human body. The membership of the subcommittee which deals with biologic tests and assays is drawn from both the medical and technical areas.

The remaining subcommittees are selected almost altogether from the technical side of the main committee. They are as follows.

The subcommittee on sterile products covers all preparations given by injection, broadly known as "parenterals," and including not only hypodermic injections but also solutions administered in large volume intravenously, and serums and vaccines.

The subcommittee on pharmacognosy is primarily responsible for physical and histologic standards for vegetable drugs.

One of the subcommittees prepares the monographs for alkaloids and heterocyclic compounds, another is responsible for aliphatic and inorganic compounds, while still another develops standards for cyclic organic compounds as well as for surgical supplies, now limited to sutures and dressings. The two strictly pharmaceutical subcommittees are those on external preparations and internal preparations.

Members of the general committee are assigned to from one to three subcommittees according to their skills and preferences. The names of the subcommittees are descriptive of their principal responsibilities; but, in the assignment of the work to each group, the director takes advantage also of any special knowledge or past experience of each chairman.

Every subcommittee chairman serves as the editorial director of his group, and is expected to bring tentative proposals and summaries of information before his group for discussion by mail. Frequently another member of the group is asked to prepare monographs for classes of drugs with which he has had particular experience. These group leaders have access to many unofficial and manufacturing control specifications which are adopted into tentative monographs for further consideration. For the verification of tentative tests and assays, specimens of newly admitted drugs are obtained from manufacturers and the open market.

The tentative draft of a monograph is presented for comment to the subcommittee and to other specialists, including a large number in commercial employment who have volunteered their cooperation. All comments are carefully considered and several revisions are usually made before printing proceeds. Roughly twelve to eighteen months are required to see a new pharmacopeia through the printer's hands. Obviously, this trip does not begin until the bulk of the manuscript is ready for the press, although many special cases are under treatment to the time of making up the printer's plates.

It is a special concern of the executives of the revision committee to make all interested parties aware of standards for new items proposed for the Pharmacopeia and of proposed changes in existing standards. There is not necessarily advance public announcement of projected meetings of the revision committee, subcommittees, or panels, but it is a matter of policy, that whenever any person wishes to be heard on a subject he is advised when a group competent in the matter will be in session.

Naturally a close liaison is maintained between the Pharmacopeia and the Food and Drug Administration, which is the agency of the U. S. Department of Health, Education, and Welfare charged with the enforcement of the Federal Food, Drug, and Cosmetic Act. The Act provides that adulteration of drugs recognized in an official compendium is determined by the tests and assays provided in that compendium. But it also provides

> . . . that whenever tests or methods of assay have not been prescribed in such compendium, or such tests or methods of assay as are prescribed are, in the judgment of the Secretary [originally Secretary of Agriculture, now Administrator of the Food and Drug Administration], insufficient for the making of such determination, the Secretary shall bring such fact to the

> attention of the appropriate body charged with the revision of such compendium, and if such body fails within a reasonable time to prescribe tests or methods of assay which, in the judgment of the Secretary, are sufficient for purposes of this paragraph, then the Secretary *shall promulgate regulations prescribing appropriate tests or methods of assay in accordance with which such determination as to strength, quality, or purity shall be made* [Author's italics].

Thanks to the efficient exchange of information, it has not been necessary to take these steps provided by the Act. Furthermore, the director of revision keeps the Food and Drug Administration promptly informed of any discussions regarding interim revision of standards.

REVISION OF THE NATIONAL FORMULARY

Much the same mechanisms are used in the revision of the Formulary as are used in the revision of the Pharmacopeia. The N.F. committee is perhaps less broadly representative than that of the U.S.P., although quite as much care enters into its selection. The standing N.F. committee is a revolving committee of ten serving five-year terms, and is the executive committee. Auxiliary members are added as required. In one respect, at least, the N.F. organization is superior to that of the U.S.P.: the American Pharmaceutical Association maintains a laboratory for development of drug standards at its Washington headquarters in the American Institute of Pharmacy, which contrasts with the dependence of the U.S.P. upon personnel and facilities provided in the laboratories where its members serve, or occasionally on those provided in return for grants from the board of trustees.

The extent of use of a drug or preparation is much more a criterion for recognition by the N.F. than by the U.S.P. This is not haphazard, however, as the scope of the N.F. is carefully guided by prescription surveys. By common understanding the N.F. grants priority to the U.S.P. with respect to the drugs selected, even though under the law the compendia are of equal standing. The N.F. recognizes many drugs as they are coming into the purview of medical practice. If they gain broad recognition, they usually appear in the next revision of the U.S.P. and are deleted by the N.F. If a drug has been official in the U.S.P. but is succeeded in favor by some new one, it may be deleted from the U.S.P. in its next revision, but, if the medical use is extensive and well approved, it is recognized by the N.F. appearing at the same time.

STANDARDIZED DOSAGE FORMS

The U.S.P. endeavors as far as possible to provide standards for only simple dosage forms of the drugs selected for inclusion. With ephedrine sulfate, for example, there are standards for a capsule, an injection, and a tablet. For each of these dosage forms there is no formula, only the requirement that the drug content shall be not less than and not more than a certain percentage deviation from the quantity per unit claimed on the container label. But ephedrine sulfate is used in combination with other drugs as well, whereby its pharmacodynamic effect or that of the other drug will be modified in desirable fashion. Combinations of this kind come especially within the purview of the N.F. Sometimes literally last-minute decisions govern the place of a drug. Acetophenetidin, with the proprietary name "Phenacetin," has been a U.S.P. item for many years. An early decision of the present scope subcommittee deemed it unscientific and it was deleted from the U.S.P. list and promptly taken into the N.F. family because of the "extent of use." But a revision of opinion took place when the soundness of its use, in combination with acetylsalicylic acid and caffeine in the almost universal "ACP" prescription, was recognized. With the two compendia ready for galley proof, the monograph was transferred from the N.F. to the U.S.P.

COADJUTANTS IN REVISION

Although these two revision committees are select as to personnel, every aid to democratic operation is employed. Reference must be made to the invaluable assistance in revision given by the Combined Pharmaceutical Contact Committee, an informal group of representatives of each company member of the American Drug Manufacturers Association and the American Pharmaceutical Manufacturers' Association. This committee, organized in 1924 at the suggestion of what is now the Food and Drug Administration, furnishes the majority of the task forces required for the expert criticism of test and assay procedures and other features of proposed monographs or revision. Probably no other industry can boast more unselfish and unbiased service than is rendered to the compendia by these committeemen.

In preparing monographs for new drugs first admitted to the official compendia, use is often made of specifications in *New and Nonofficial Remedies,* an annual publication of the Council on Pharmacy and Chemistry of the American Medical Assocation. "Council-accepted"[8] drugs may be new drugs just coming into professional favor but not yet recognized in official compendia, or dosage forms that comply, or whose manufacturers comply, with certain specific council rules regarding advertising, therapeutic claims, names (both proprietary and generic), openness of the formula, and usefulness or scientific foundation for the article. Although it confers no official status, recognition of a new product by N.N.R.

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[8] The "acceptance program" of the AMA Council on Pharmacy and Chemistry was discontinued in 1955. The Council now recognizes new drugs by publishing evaluations of their merits and uses without implying acceptance.

brings it to the attention of the highest echelons among medical practitioners, whose eventual approval will certainly bring the recognition in an official compendium.

Consist of the Pharmacopeia

The Fifteenth Revision of the U. S. Pharmacopeia contains 838 separate monographs for medicinal substances and preparations. Of these, about 46 per cent are included as basic drugs; 14 per cent as pharmaceutical necessities for manufacture of the medicinal preparations official therein, and 40 per cent as simple dosage forms. The Tenth Edition of the National Formulary, appearing at the same time, contains 735 separate monographs, 41 per cent basic drugs and 10 per cent pharmaceutical necessities, the remainder being simple dosage forms. While the U.S.P. and N.F. may both deal with forms of the same drug, there is no overlapping since the two compendia do not cover the same forms of any one drug. The U.S.P. and the N.F. are identical in style, and these monographs, in general, conform to the following arrangement.

Official Title

A monograph for a drug begins with the official title, or name, which is an actual name or a coined generic or non-proprietary name, followed by synonyms by which it is extensively known. No proprietary name protected by a trademark or copyright is used as an official name or synonym. The standard requirements attached to these official names apply only to medicinal grades of the articles.

Definitions

The title of an official article is part of the definition. If the article is a chemical compound of known composition, its chemical formula is a part of the definition; a structural formula if organic, empirical if inorganic. If its constitution is not known precisely, it may be defined in terms of its origin or its major chemical characteristic. If there is a standard for strength, it is incorporated in the definition, which is then called the *rubric*. For a vegetable drug or preparation thereof, the standard may be the percentage of active constituent; for a medicinal chemical, the purity expressed as per cent; for a dosage form of a chemical, the percentage of compliance with the labeled claim of content; or for a drug of unknown constitution but known activity, its equivalence to some reference unit.

Strength, Quality, and Purity

If of known constitution and customarily manufactured in a high degree of purity, the physical characteristics of an article, such as melting range, together with such simple requirements as loss on drying and residue on ignition may suffice to establish its strength without the need for an assay. If there are not a sufficient number of definitive tests available, an assay is desirable. A reasonable tolerance is allowed in standards to account for small amounts of innocuous impurities, the cost of removal of which would be more significant than the slight reduction of strength. Ordinarily a purity of 98.5 to 99 per cent is considered a satisfactory degree of medicinal purity, because dosage calculations are not stoichiometrically precise. If the purity is based upon some one constituent among several, an upper limit is desirable in addition to the lower to establish a uniformity of composition. When, on the other hand, the article is a dosage form of a drug, account is taken of the fact that a tablet, a capsule, or an injection may be produced in several concentrations of active ingredient, hence the purity is based upon the label declaration.

Aspirin is the popular synonym for the drug known chemically as acetylsalicylic acid. Official aspirin must contain not less than 99.5 per cent of the pure chemical substance. Aspirin tablets are made to contain 60 to 300 mg. of drug per tablet, an approximation of the apothecaries' one to five grains. Assuming the aspirin used to contain 99.5 per cent of acetylsalicylic acid calculated as $C_9H_8O_4$, the formula for the tablet mix is adjusted to make theoretically a tablet containing 100 per cent of the labeled amount as shown by assay, rather than 100 per cent of 99.5 per cent. Since even the most accurate blending and dividing machinery can err, such a tablet is required to contain, according to the assay, not less than 95 per cent and not more than 105 per cent of the pure chemical substance. When deciding on the tolerance to be allowed in the active content of a dosage form, the major considerations relate to the potency of the drug and the "grainage" of the dosage form.

The description of the drug based on its physical state, as liquid or solid, crystalline or amorphous, color, odor, and sensitiveness to deterioration, are part of the means of identification. The official identification tests for a drug are not for its identification as an unknown, but to secure qualitative compliance with the label. Identification tests are, desirably, definitive of the substance. Unfortunately there are still some drugs of desirable medical utility that respond only to class reactions, no one test being wholly specific. However, the response to three or four, properly chosen tests, may pinpoint the identity of a chemical substance. This is particularly so if a test for identification involves conversion to a derivative that itself has some precisely measurable physical characteristic. The pharmaceutical chemist has long relied upon such physical characteristics as melting range, solidification temperature, density, specific rotation, and refractive index as tests for both identity and purity. Such a chemist's task is greatly aided today by ultraviolet and infrared spectrometry.

The chemical tests for purity may be either general tests for common reagent residues or specific tests for a dangerous contaminant likely to result from the method and equipment needed in the manufacture. The degree to which a drug has been purified may be judged frequently by conducting a limit test for the sulfate ion, since sulfuric acid is used so extensively in the synthesis of drugs. A satisfactory degree of technical skill in manufacturing almost any chemical substance may be assumed if the sulfate-ion content does not exceed 200 parts per million. On the other hand, arsenic being itself physiologically potent, when any raw materials used in manufacturing are likely to contain arsenic, a limiting quantitative test for arsenic is prescribed for that product. A third kind of purity test is one that limits the amounts of byproducts of side reactions during synthesis to a safe figure. In most cases refining of a drug to 100 per cent purity cannot be justified on either economic or therapeutic grounds.

Assay

The ideal assay is one that is definitive of the substance, such as the assay of sodium sulfate by quantitative determination of a barium sulfate precipitate. The derivative upon which the assay is based is identified by the manner of performing the test. Somewhat analogous is the assay of opium preparations for their content of morphine alkaloid, taking advantage of two characteristic reactions of morphine which, together, eliminate other vegetable bases occurring in opium. Less desirable, but sometimes the only analytical recourse, are those assays in which the characteristic active principle of a drug is never isolated, but a characteristic element or grouping determined, such as the iodine in thyroxin, the active principle of the thyroid gland. A fourth type of assay measures a chemical property, such as the amount of replaceable hydrogen in an acid. A fifth measures a physical characteristic of an official substance or a derivative, as the determination of ultraviolet transmittance at some specific wavelength.

Bioassay

There is another type of assay that must be employed when the active principles of a drug cannot be quantitatively isolated and they contain no characteristic element or group susceptible of chemical or physical determination. Since every drug is used because of some characteristic pharmacologic activity, that activity, if measurable, may be based upon the degree of reaction produced on the most susceptible animal, or upon an excised organ or tissue. Difficulties lie in finding a suitable animal, or a standardized animal, and in the precise measurement of the effect. There are many more variables in bioassaying than in chemical analysis; hence the data so obtained, especially during development and evaluation of the method, must be subjected to critical statistical analysis.

Reference Standards

Research in this century has produced so many new specific medicinal agents that a physician or a drug analyst who has been twenty years in practice is dealing most of the time with articles that have appeared on the scene since he left college. Whereas the analyst once relied almost altogether on classical gravimetric and volumetric analyses, he now deals largely with comparison measurements. The U. S. Pharmacopeia has recognized its responsibility in this matter by having prepared, and distributing, reference standards for use in such comparisons. Blended lots of material of highest purity, usually from several sources, and, if chemical compounds, further purified as one batch, are assayed by control laboratories (with special experience in the particular area) and by the governmental drug control laboratories in Washington and Ottawa. These reference standards are distributed by the U.S.P. office on a nonprofit basis. U.S.P. XI, official in 1936, described four reference standards, while U.S.P. XV describes more than fifty. Some other reference standards are provided for standardization of the melting point determination.

Packaging and Storage

Correct packaging and storage of drugs, chemicals, and medicinal preparations prior to retail distribution is essential in preserving their quality and strength. Directions for packaging and storage are part of each monograph. The revising groups have also organized industry panels to aid in the improvement of standards for containers and closures. Storage requirements cannot be extended to cover medicines as dispensed. Prescriptions are intended to cover a condition of the moment, but householders tend to hoard unused medicines against future undiagnosed needs.

Reagent Standards

Adequate laboratory control of drugs depends upon three factors, the competence of the described details of the tests, the skill of the analyst, and the quality of the reagents and calibrated apparatus used. The National Bureau of Standards is the authority on the basic principles of calibration. Standards for necessary reagent chemicals are to be found in the U.S.P. as are the formulas for testing solutions. Many of the reagent standards authorized are those developed by the American Chemical Society, but for special reagents, the compendia must develop their own standards.

Standardized Medicinal Preparations

Reference has been made mostly to the requirements for drugs rather than for their preparation. But the requirements for the official preparation of these drugs are strict to substantially the same degree. Of major consideration is the concentration of the drug or its active principle in the preparation. This may be secured by requiring (1) the use of a set formula and a drug complying with all official specifications, or (2) an assay of the finished preparation, as the character of the drug indicates. There are certain instances in which the only standard for comparison is another lot of the preparation made according to the official formula from a specimen of drug the authenticity of which is beyond question. In the case of an adulterated ginger tincture sold in the prohibition era for beverage purposes, which produced a type of paralysis, the adulteration was found to consist of substituting for much of the ginger a common lacquer plasticizer, tricresylphosphate. The court held that since an authentic ginger tincture did not contain this substance its presence in the poisonous tincture was an adulteration.

Changing Requirements

Much effort is made to avoid the freezing of a standard in order that these compendia shall not stand in the way of scientific progress. Two bound supplements to U.S.P. XI were issued. The 1940 convention later authorized five-year revision periods as well as interim revision, and the American Pharmaceutical Association took similar action in regard to the N.F. Supplemental announcement of interim revisions is made as soon as the change is authorized by the committee. At intervals these interim announcements are assembled in supplements. Federal drug legislation recognizes the supplemental announcements issued by either compendium as superseding the standard of the compendium as originally published.

INTERNATIONAL SCOPE OF THE U.S.P.

The pharmaceutical industry has an extensive trade with Latin American countries, and many physicians and pharmacists there are in touch with their counterparts in the United States. During the first decade of this century, there was enough agitation for a Spanish translation of U.S.P. VIII to cause the U.S.P. Board of Trustees to employ Professor José G. Diaz of the University of Havana to prepare a suitable translation, which was issued by the publishers of the English language edition. Later the translation was under the auspices of the Pan-American Sanitary Bureau, while the latest translations have been made by the University Society Mexicana, S.A. Currently the Spanish translation is the official guide in the Republics of Cuba, Honduras, Panama, and Puerto Rico, and is used, together with the French Pharmacopeia, in Ecuador, Guatemala, Bolivia, Colombia, and Nicaragua. Incidentally, the United States Pharmacopeia is the official compendium for Ethiopia.

The industry and the profession in the United States have recently been much exercised over the preparation, by a commission of experts of the

World Health Organization of the United Nations, of the *Pharmacopoea Internationalis.* As a reference work it is well conceived, for it presents in a style that is largely a compromise between the U.S.P. and the *British Pharmacopoeia* the essential characteristics of the drugs that are international in use and scope. Those who depend upon the U.S.P. for guidance have become conditioned to a certain type of requirement for medicinal substances. Certain other countries have traditions regarding the necessary standards for drugs that they are loath to give up. The choice of the name "Pharmacopoea" for this compendium was probably unfortunate, for it has aroused substantial resistance in the United States, as an example of undesirable internationalism. Yet there is an excellent opportunity for a work of this type that would bring together for reference the official drug standards of the subscribing governments in a manner not suggestive of compulsion.

A SYMBOL OF PROFESSIONAL SELF-GOVERNMENT

Nowhere else in the world will be found such compendia of professional and industrial end-use standards as the U.S.P. and the N.F. represent. No standard ever takes effect until every opportunity has been given for trial and discussion by all interested persons, and until every lawful difficulty has been resolved. As textbooks, they combine organic chemistry, analytical chemistry, pharmacology, and therapeutics. The majority of states make it mandatory to keep a copy of the latest revision of each compendium in every licensed pharmacy. They are the principal handbooks employed in manufacturing control laboratories, the dictionaries of the tongue in which the industry and the profession converse. And they represent probably the most advanced means of professional self-government known. The standards of the U. S. Pharmacopeia and the National Formulary do not cover every article that is offered for sale as a drug or medicine. There are manufacturers of packaged remedies intended for popular sale that try to avoid the requirements of the Pharmacopeia in an attempt to avoid any classification that would restrict the item to professional distribution. But these official standards do apply to every medicinal substance that through the consensus of the medical profession or extent of medical use is deemed suitable for the treatment of disease.

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20. STANDARDS FOR MEDICAL, SURGICAL, AND HOSPITAL SUPPLIES

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QUALITY CONTROL of supplies and equipment as a part of the purchasing procedure has not become a policy of hospital management as it has of private industry. Although standards of quality are available for every important product bought by hospitals, they are little used. This essay will survey the scope and sources of these standards and examine the reasons for their neglect. Suggestions will be made for procedures that will enable hospitals to use standards effectively in purchasing.

HOSPITALS' INDIFFERENCE TO STANDARDS

Hospitals began as charitable, tax-free institutions to care for the poor. Gifts were their chief support and businesslike methods of handling money were thought unnecessary or even a little degrading.

Hospital employees were frequently poorly trained and poorly paid. Purchasing agents were seldom employed. The charitable flavor of the entire operation was extended to the vendors, whose products were accepted with no checking of serviceability or comparative worth.

The easygoing, charitable viewpoint has persisted down to the present in many hospitals. Deficits are taken for granted, and so are drives for donations. Rarely does hospital management concentrate on more efficient use of money to reduce deficits.

Because large grants are declining, modern business methods are being used increasingly to build up revenue from patients and from small donors. But spending is still haphazard. Less than 10 per cent of the some 6500 nongovernmental hospitals have established controls over quality, i.e., regularly request quotations, buy on specifications, and check test on delivery.

A major reason for unscientific buying is the fondness of the medical and nursing staff for certain dominant brands. A few hospital administrators have had the will and the authority to curb blind loyalties to brand names, and in some other cases the problem has been handled by forming committees on standards with authority to prescribe and purchase products of a specified quality no matter what the source.

Another hindrance to quality control is the fact that purchasing agents are often overworked. They cannot find time to assemble standards and seek out new sources of supply. In hospitals where there is no centralized buying (and these are the majority), the director, head nurse, dietitian, and engineer are compelled to make an added job of placing orders. Generally they do not study the market or make any attempt to prescribe quality. They buy from relatively few sources, and almost invariably they waste money.

STANDARDS FOR EVERYTHING

There exist today standards of quality or specifications for practically everything that hospitals buy. Many of these standards are usable without change or could be readily adapted for hospital procurement.

Quality definitions of several specific hospital products are in the form of Commercial Standards. Many others are described in Federal Specifications. Others, especially in the medicinal field, are listed in the United States Pharmacopeia. The American Medical Association and the American Dental Association also report on certain classes of medical products.

General institutional products (food, paints, waxes, cleaning compounds, textiles) are covered by the standards or specifications of such federal agencies as the General Services Administration, Department of Commerce, and Department of Agriculture. Other standards are available from independent professional associations, notably the American Standards Association and the American Society for Testing Materials.

WHY STANDARDS?

The demand for standards in the hospital field has come from two sources: (1) federal, state, and municipal hospital and health services, and (2) government enforcing agencies. Because of legal requirements and the importance of economy and fair procurement, federal hospitals use specifications far more than any other group in health service. Many state, county and municipal hospitals are also required to follow specifications in obtaining bids and checking on deliveries. In government buying there is less and less use of the expression “equal to or better than brand A” or to that of a sample submitted. The general rule now is to spell out complete and precise definitions of quality.

A major impetus for standards in the medical field has been the regulatory functions of the Food and Drug Administration. Effective regulation requires yardsticks for comparison of products. The United States Pharmacopeia is the chief source of standards for drugs and allied items (dressings and sutures, for example). Similarly, the regulatory powers of the Federal Trade Commission and the Department of Agriculture depend upon standards developed by these agencies or generally accepted by the trade.

Only within the last few years have private institutions begun to discover how they can save money and improve service through the use of standards. Thanks to the purchasing institutes held by the American Hospital Association and the Catholic Hospital Association, hospital purchasing agents are beginning to make limited use of standards. The test reports supplied to its members by the Hospital Bureau of Standards and Supplies in recent years were eyeopeners. For the first time branded products that hospitals had accepted as the acme of perfection were tested, analyzed, and in many cases found wanting. The Bureau's reports showed that often there is little or no relation between quality and price. Brands costing 20 to 50 per cent more were frequently proved no better if not poorer than less expensive brands. It is not unusual today for a small, relatively unknown manufacturer to achieve exceptionally high quality.

By failing to control the quality of their purchases, hospitals have invited the dumping of substandard goods. It is an established fact that thermometers rejected by federal procurement agencies go into the private market—often into hospitals. Because private hospitals do not rigidly inspect materials on delivery, the vendor is under no pressure to maintain high uniform quality.

The hospitals' failure to obtain first quality products is costing them many millions each year. John J. Brennan, Jr., in his article "Hospitals Need Business Know-How,"[1] estimated that the average hospital can save up to 10 per cent through better prices, better quality control, and better inventory control. This is a very conservative figure. Knowing from long experience in testing hospital supplies that high prices are commonly paid for mediocre goods, the writer believes that 10 per cent could be saved through good quality control methods alone.

SIMPLIFICATION AS A PART OF THE STANDARDS PROGRAM

A well prepared standard should not only assure good service but also fit the production possibilities of several companies. It is important that the purchasing agent help to stimulate competition. He can do so only with a standard that several vendors can readily meet.

Standardization should promote simplification: reduction of the number of types, sizes, etc. The fewer varieties a manufacturer produces, the lower his costs. By limiting themselves to the truly essential sizes and varieties, hospitals can reduce their own inventories and save a great deal of paper work in purchasing and physical work in handling.

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[1] John J. Brennan, Jr., "Hospitals Need Business Know-How," *Harvard Business Review*, Vol. 32, no. 5 (September-October 1954), pp. 92-100.

The pharmacy is the first place for simplification. All too frequently the doctors will order from different manufacturers several drugs which have the same therapeutic function. This practice requires more storage space and complicates the inventory. Frequently supplies are lost because of limited use and over-age. Simplification could be established by forming a pharmacy committee to prepare a limited drug list or formulary which would be adhered to by every doctor. The committee must have enough authority to refuse special pleas for additional items or brands.

The same principle can be extended to many other departments. Textiles, paper products, and cleaning compounds are often bought in a wide variety of types, sizes, and brands. If the department heads formed a committee to agree on a limited number of products, the size of orders could be increased, inventories reduced and lower prices obtained. Organizing the purchase of supplies on a six-months or yearly basis will minimize emergency orders, cut down on paper work, reduce prices through larger volume and strengthen quality control.

WHO IS RESPONSIBLE FOR STANDARDS?

Many agencies are active in the standardization of medical supplies. Because of the recent emphasis on military procurement, the federal agencies have contributed most. But for many years there have been contributions by semiprofessional, technical, and trade groups. Their methods and results will be briefly reviewed.

American Hospital Association

The most important work in developing standards for hospitals has been done by the Committee on Purchasing, Simplification, and Standardization of the Council on Administrative Practice. The Committee, which began in 1923 as the Committee on Hospital Furnishings and Supplies, has cooperated closely with the Department of Commerce. It has developed a list of twenty-three standards of quality or simplified practice recommendations primarily for hospitals, and it has helped formulate standards for many general products used by institutions.

These standards sponsored by the American Hospital Association have been promulgated by the Department of Commerce as Commercial Standards:

Commercial Standards

Clinical thermometers
Steel bone plates and screws
Hospital rubber sheeting
Surgeons' rubber gloves
Surgeons' latex gloves
Mattresses for hospitals
Hospital sheeting for mattress protection
Blankets for hospitals
Gowns for hospital patients
Latex foam mattresses for hospitals

Simplified Practice Recommendations

Hospital beds
Clinical utensils
Surgical dressings
Hypodermic needles
Hospital plumbing fixtures
Cotton textiles
Hospital chinaware
Color marking for anesthetic gas cylinders
Surgical gauze
Adhesive plaster
Surgical sutures

The committee is currently preparing standards for casters, wheels, and glides; cotton blankets; prepackaging of surgical dressings; surgical instruments; hospital beds; and revising the standards for surgeons' gloves.

Hospital Bureau of Standards and Supplies

This is an independent, nonprofit agency, run by 250 member hospitals. It was organized to save money by consolidating purchases of major surgical products. Later the Bureau launched a standardization and research program to find quality products at a fair price and to inform its members on the results of testing major classes of products. Standards for the items it buys are generally limited to Commercial Standards and Federal Specifications.

Through its comparative tests of quality the Bureau has done more than any agency in the hospital field to highlight the importance of standards. The tests have also encouraged manufacturers to raise their own standards. For example, when clinical thermometers were first tested in 1943, 40 per cent failed to meet the Commercial Standard requirements—although every sample was represented as conforming. A test in 1953 showed that failures had dropped to less than 20 per cent despite tightening of the standard.

It was not until the Bureau investigated hypodermic needles that hospitals became aware of the large percentage containing minute metal particles and wire edges at the point, the residue from manufacturing. After a number of reports, needles have been improved markedly and sources have been found for correctly sharpened needles with practically no extraneous particles.

The Bureau has made purchasing agents aware of the kinds of failures likely with soaps and cleaning compounds, hypodermic syringes, textiles, rubber goods, paints, and other items. Buyers are increasingly following the Bureau's recommendations in their choice of products.

Department of Commerce

Commercial Standards and Simplified Practice Recommendations are developed and promulgated by the Commodity Standards Division of the Department of Commerce. Although strictly voluntary, these standards help bring user and manufacturer groups together in an effort to eliminate lowgrade or worthless products. In addition to the American Hospital Association Standards already mentioned, the Commerce Department has promulgated hundreds of standards for items of direct importance to hospitals. Among these are disinfectants, insecticides, wood preservatives, wall tile, melamine tableware, hardware, porcelain enamelware, aluminum utensils, insulating materials, and many types of petroleum products and building materials.

United States Pharmacopeia

There is no greater compendium of standards for medical and surgical supplies than *The Pharmacopeia of the United States of America.* It is the pharmacists' bible, and as purchasing agents take over drug buying it will become their principal guide too. Not known to most buyers of medical supplies is the fact that the Pharmacopeia gives standards not only for drugs and pharmaceuticals but also for many other materials such as absorbable and nonabsorbable sutures, absorbent gauze, purified cotton, absorbable gelatin sponges, liquid surgical soaps, and medical soap soft.

Although most pharmacists are thoroughly familiar with the Pharmacopeia, it is an astonishing fact that many buy almost wholly by brand name rather than by U.S.P. standards. The reason is the medical staff's habit of prescribing by brand names instead of using a scientific description. Doctors in particular hold to the popular notion that products sold by the best known drug houses are superior to those of smaller manufacturers—even though both must meet the U.S.P. standards. The average hospital could save thousands of dollars in drug buying if it established a pharmacy committee with the authority to buy according to the standards of *The National Formulary* and the U. S. P.

Because federal and other governmental agencies recognize U.S.P. standards and because the Food and Drug Administration enforces them, drugs and pharmaceuticals are probably the most effectively standardized products on the American market. A pharmacist may buy from almost any source and be reasonably sure of getting satisfactory drugs.

Mention should be made of the Food and Drug Administration's remarkable job in supervising production of antibiotics. The strict standards of the FDA are enforced by a testing program which requires that samples of each lot be submitted for analysis. A group of the larger manufacturers, long opposed to this control, has been conducting a campaign for discontinuance of the certification program.

Joint Commission on Accreditation of Hospitals

Although quality standards for products have little part in its program, the Joint Commission on Accreditation of Hospitals should be cited. Until 1952, accreditation was handled by the American College of Surgeons under the direction of Dr. Malcolm T. MacEachern. The Joint Commission then established consists of members from the American Medical Association, American Hospital Association, American College of Surgeons, American College of Physicians, and Canadian Medical Association.

As in the past, much of the work under the new accreditation program encompasses standards for hospital plants, administrative organization, and quality and quantity of the medical, nursing, and laboratory services. This program has been a major force in establishing high standards for medical care. Unfortunately, it has not included standards of materials and procedures. There are, for example, no generally accepted standards for sterilization of instruments and dressings or for preparation of patient and staff for surgery. Hospitals are still wasting manpower and materials —and often not protecting their patients adequately.

The accreditation program does not safeguard patients against possible explosions in the operating room. This problem has been studied by a special committee working with the National Fire Protection Association. While headed by George H. Buck, the committee issued a set of minimum standards, "Recommended Safe Practice for Hospital Operating Rooms," covering the explosive hazards of anesthesia gases. Recommendations include special switches and electrical equipment and standards for the conductivity of floors, furniture, sheeting, tubing, and other devices. These are minimum safety standards. Yet only a small number of hospitals has given any recognition to this standard and no agency has the power to enforce it.

American Medical Association

Although now discontinued, the work of the Council on Physical Medicine and Rehabilitation of the American Medical Association was of major significance. The Council established standards and appraised medical devices that use ultraviolet and radiant energy, heat, cold, water, and electricity. It also passed on machines for massage, manipulation, and exercise, as well as diagnostic and physical therapy equipment.

Although the Council's standards were not all one would wish in terms of construction and operating efficiency, the list did represent an important effort to eliminate useless medical gadgets. There was, no doubt, more back of the decision to drop this service than the need to put more effort into other activities, as announced at the time the service was discontinued.

The United States Pharmacopeia and National Formulary cannot keep abreast of new drugs and medical devices, despite periodic revisions. To give physicians advice on the newest products, the Association's Council on Pharmacy and Chemistry rates these drugs in the monthly *Journal* and the annual *New and Nonofficial Remedies.* Some useful new drugs may do more harm than good if administered unwisely. The Council depends largely on pharmaceutical manufacturers who cooperate by submitting new products with laboratory and clinical studies for evaluation. Fortunately the Council has been putting increased reliance on independent consultants in the various branches of medicine.

The Association's Council on Food and Nutrition, having dropped its program of judging food products of all kinds, limits its approval to foods for infants and for special diets. The value of the Council's work is illustrated by its successful efforts to induce dairies to add vitamin D to all milk, which helped importantly in the virtual elimination of rickets.

American Dental Association

Through its Council on Dental Therapeutics and its Council on Dental Research, the Association is doing an outstanding job in testing and evaluating materials used by dentists and the public.

The Council on Dental Therapeutics apprises dentists on the worth of a great many items including anesthetics, antiseptics, antibiotics, dentifrices, mouth washes, and mechanical aids. Chemical products are examined at the request of the manufacturer or upon the initiative of the Council. This service is notable for its scope, its thoroughness, and its independence.

All items studied are listed in one of four groups—A, B, C, and D. Only those in Group A are accepted without qualification. Group B products are not accepted but reasonable evidence exists for their usefulness and safety. Included in Group C are products that cannot be appraised without further study. Undesirable products are put into Group D. All of the Group A items are listed in *Accepted Dental Remedies,* which is revised each year.

Interestingly, at the present time no commercial dentifrice is included in either Group A or Group B. The Council believes that dentifrices containing antibiotics are dangerous and that the evidence in favor of those with chlorophyll, urea, ammonium compounds, or inorganic chloride is not conclusive—hence, these products are not acceptable.

Many other commercial products including disinfectants, antiseptics, and mechanical aids are classified by the Council.

The Council on Dental Research maintains a research fellowship at the National Bureau of Standards and works closely with the Bureau. Behind the Council's list of certified dental materials are many years of basic study and research at the Bureau. The Council has prepared specifications for dental amalgam alloys, dental silicate cement, denture base and resin, dental inlay casting wax, and other regularly used items. The dentist gets not only the specifications but also the list of manufacturers who follow the specifications.

Food and Drug Administration

Purchasing agents should be familiar with the work of several federal agencies that control many of the items they regularly buy. Probably the best known program is drug control by the Food and Drug Administration under the U. S. Department of Health, Education, and Welfare. But it is not generally understood that FDA also regulates medical devices and may seize in interstate commerce any that are mislabeled, hazardous, or otherwise below standards. These devices include syringes, needles, thermometers, urinometers, therapeutic lamps, X-ray machines, electric cardiographs, and so on. Standards for drugs and devices issued by the United States Pharmacopeia are enforceable by FDA.

Main functions of the Administration include:

1. Checking the safety of all new drugs before they are put on sale.
2. Enforcing the law against bogus therapeutic devices.
3. Testing all batches of insulin and five of the most important antibiotics for purity and potency before they are sold.
4. Checking imports of foods, drugs, and cosmetics to make sure they comply with our laws.
5. Policing the purity, quality, and labeling of foods, drugs, and cosmetics. This is the Administration's most important job.

Violations are regularly reported in the FDA's *Notices of Judgment.*

The FDA has prepared definitions or standards of identity for every important food product. Establishing and supervising quality standards for all kinds of processed and fresh fruits, vegetables, dairy products, and meats is, however, a major activity of the Department of Agriculture.

General Services Administration

This agency is responsible for developing all federal specifications including supplies and equipment for medical institutions. Included in the long list are surgeons' gloves, catheters, syringes, needles, sterilizers, urinometers, stethoscopes, sphygmomanometers, surgical instruments, surgeons' blades, X-ray supplies and equipment, surgical dressings, adhesive tape, elastic bandages, cleaning compounds, waxes, paints, textiles, and paper goods.

Most things that an institution needs are covered by a Federal Specification. For the few exceptions, the medical buyer should turn to one of the branches of the armed services. Standards for medical supplies not covered by Federal Specifications may usually be had from the Armed Services Medical Procurement Agency, the Veterans Administration, or the Surgeon General's Office of the Army or Navy.

Important research on standards for equipment and procedures has been undertaken by the Surgeon General's Office. Particularly useful to hospitals are the studies and recommendations dealing with central sterile supply, nurses' call systems, and adaptation of addressograph for patient records.

American Standards Association

Although primarily concerned with industrial standards, the ASA is one of the few independent private agencies that has taken an interest in developing standards of quality for consumer groups.

Recently the Association has undertaken some work in the medical field. Subcommittees are working on (1) nomenclature for syringes and needles, (2) interchangeability of luer connections for medical devices, and (3) standardization of intravenous sets.

The Association is also concerned with standards for general institutional supplies. Under sponsorship of the American Hospital Association it promulgated the first national standard on textiles—i.e., sheets and pillowcases. An ASA standards program for all major institutional textiles is being sponsored by the American Hotel Association.

American Society for Testing Materials

The chief function of this organization is developing standard test methods. Its work is basic to a great many of the standards and specifications used throughout the nation.

Of interest to hospitals are numerous ASTM specifications, including those for soaps and cleaning compounds, paints, paper, textiles, and petroleum products.

WHY TESTING IS NECESSARY

Because of the tremendous number, complexity, and critical importance of materials used in hospitals, purchasing should be guided by facts about comparative quality. Actual use cannot possibly provide reliable information quickly enough. If the purchasing agent is to find the best product at the fairest price, he must have access to independent laboratory data. A few examples will illustrate the point.

Hypodermic syringes were greatly improved when barrels and plungers were made interchangeable. But each manufacturer still has his own dimensions for the various sizes of syringes, which makes interchanging between brands impossible. Any hospital that adopts one brand is automatically cut off from other sources of supply. Prices and quality cannot be competitive under these circumstances.

The most common failure of interchangeable syringes is leakage. Although tests have failed to reveal any brand that is completely satisfactory in all the standard sizes, some less expensive syringes have proved just as good as the most expensive.

The most widely used brands of surgeons' gloves are not the highest in quality. A less known brand has shown consistently higher quality over a period of several years. But surgeons continue to insist on the traditional brands, especially a popular brown milled glove which was the poorest of five brands tested.

Two surgical dressing manufacturers dominate the hospital market. Their prices are identical for all types and quantities. A few small manufacturers are becoming well enough established to offer effective competition. Comparative tests of surgical dressings have shown that the only real difference between the big and little brands is price. Yet many hospitals continue to pay for the prestige of the well known brands.

Because textiles are highly variable, constant testing is essential for sound buying. For example, repeated tests of Type 140 sheets have shown about 30 per cent failure against the American Standard. Only one or two brands maintained generally high quality, and even these slipped occasionally.

There is only one way to enforce quality and that is by continuous testing and sampling of the delivered product.

A STANDARDS PROGRAM FOR HOSPITALS

To have a workable quality control system, hospitals must take four steps:

1. Stop buying on the basis of brand names only.
2. Coordinate buying and reduce the variety of items purchased.
3. Establish standards or definitions of quality that will make it possible to obtain bids on items bought in large quantities.
4. Require that products conform to the standards.

What are the practical ways to verify the quality that has been specified? Any one of these three programs would meet the need in most institutional purchasing:

1. *Group Research and Testing*

The best example of group activity is the Hospital Bureau of Standards and Supplies in New York City. Throughout the country, a number of hospital councils now pool the buying requirements of their members. Unlike the Bureau, they have no testing program. The addition of a testing plan would greatly enhance the value of these centralized purchasing efforts.

But there would still be no check on the quality of items not included in the centralized purchasing. This shortcoming could be overcome if member hospitals gave their central buying agency enough funds to test all major items purchased individually. Quality standards for this program would be mainly the existing Commercial Standards, Federal Specifications, American Standards, and the U.S.P.

2. *Development and Enforcement of National Standards*

A complete set of standards for medical and hospital supplies could be developed through such agencies as the Department of Commerce, the American Standards Association, and the American Society for Testing Materials. To succeed, it would need genuine support from the major industries, especially those represented in the American Surgical Trade Association and the Manufacturers Surgical Trade Association. The producer and seller groups should recognize the hospitals' stake and allow full institutional representation on all standardization bodies.

Precedents for this program have been set by several trade associations, such as the American Gas Association. This group has provided standards for gas equipment that are reasonably high and well enforced. Another example is the safety certification program of the Underwriters' Laboratories for many classes of supplies and equipment. Whether the manufacturers and dealers in the medical supplies and equipment would be willing to work together for a successful program of standardization is a question this writer will not try to answer.

3. *Standardization for and by Hospitals*

A program for testing and certification carried on by the hospitals themselves would provide the greatest benefits to them. The logical organization to handle it would be the American Hospital Association.

The Association could readily undertake a testing program to establish standards and set quality levels to achieve maximum service per dollar. Much more difficult would be a certification program that could be enforced.

An advantage of this proposal is that testing and certification would be directly controlled by the consuming group and therefore independent of commercial bias. The Association could better serve the needs of its members than could any organization oriented to industry. There should be no financial problem, for the savings to members would pay for the program many times over.

Since hospitals buy an enormous number of different things, it would be necessary to limit the program initially at least to products not now included in any certification program. Among them would be such consumable items as surgical dressings, disposable intravenous sets, surgical instruments, sutures, surgeons' needles, and rubber gloves. Textiles, cleaning compounds, waxes, and the like should be covered in a certification program for all institutional groups.

The time has come for the hospitals to take on some problems of research and development instead of leaving everything to industry. There are many phases of hospital operation—and many connected with purchasing—which should be studied under controlled conditions. The armed services have made a beginning, and civilian hospitals should join in. What the American Medical Association has done in coordinating and stimulating medical research illustrates the kind of activity needed in the hospitals.

The research program of the American Dental Association is an outstanding example of what a profession can do for itself and for the public it serves. The quality standards established by the Association are models for any agency entering this field.

Each of these three proposals has certain advantages. In the opinion of the author, the last one holds the greatest possibilities of service to hospitals.

No matter what plan or plans may be adopted, the goal must be broader use of standards in hospitals. Purchasing should be a major concern of top management, and standards are fundamental for successful purchasing.

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21. STANDARDS IN THE FEDERAL SUPPLY SYSTEM—CIVILIAN GOODS

WILLIS S. MacLEOD

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Introduction

SINCE REVOLUTIONARY times efforts have been made in government to achieve some semblance of buying centralization and reasonable uniformity in the type and quality of the goods used by the federal government. Alexander Hamilton, the first Secretary of the Treasury, in 1795 established the Office of the Purveyor of Public Supplies. The Dockery Commission in 1893, and the Keep Commission in 1905, made surveys and recommendations toward furthering these objectives.[1]

These efforts contributed to the improvement in federal supply operations, but it was not until the survey and report to the Congress of the first Hoover Commission that the Congress fully recognized the importance of establishing an efficient and economical system of supply in the federal government. This recognition by the Congress culminated in the passage of Public Law 152 (81st Congress) known as the Federal Property and Administrative Services Act of 1949. For the first time in the history of our country, the Congress established by statute a central agency to manage the property and supply activities of the federal government and provided the basis for a fully coordinated government-wide standardization program. The General Services Administration was created to perform these functions.

That standardization is basic to any efficiently organized and operated supply system is well accepted. Standards are indispensable to public

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Invaluable assistance was given the author by Mrs. Helen Robinson Wright and Miss Isabel Macdonald in gathering the materials for the essay and its editing. Mr. O. W. Teckemeyer, Director of the Inspection Division, FSS, developed the section on inspection and testing.

[1] For detailed review of background and development see Willis S. MacLeod, "Twenty-seven Years of Federal Specifications," *Standards World,* Vol. 1, no. 3 (Summer 1949), pp. 1-20.

purchasing. In the *Task Force Report on the Federal Supply System* (of the Hoover Commission) it was stated that: "Specifications are not an end in themselves, but are an essential part of the purchasing process. They are particularly important in governmental purchasing where the award must ordinarily be made to the lowest bidder whose product conforms to the prescribed standard."[2]

This competitive bid system of public award provides an equitable basis upon which suppliers may compete for government business and insures that full value is received for the taxpayer's dollar. Standards establish precisely what is wanted, set the level of quality which is to be met, the basis of measuring it, and the means of comparative evaluation of quality, serviceability, and price under competitive bid offers.

Federal Commodity Standards—Background

The Federal Supply Service of General Services Administration brings together all personal property management activities necessary to a full-scale centrally directed supply program. (See Chart 21-1.) These activities are supply management, purchase, stores, personal property utilization and disposal, motor equipment operations, inspection, and standards.[3] The purchase organization consists of a division handling purchase policies and methods, and a division for consolidating national buying operations. Traffic and transportation as a function directly related to supply was formerly organized as a division within Federal Supply Service. In recognition of its tremendous importance and the large federal expenditures for shipping and public utilities, the Administrator established, effective July 1, 1955, a coordinate service known as the Transportation and Public Utilities Service of General Services Administration.[4] This brings together the transportation and utilities activities formerly in Federal Supply Service, Public Buildings Service, and Emergency Procurement Service.

The standards function consists of standardization, specifications, cataloging (commodity classification and item identification), and inspection and testing of materials. Standardization, with respect to end items of supply, and engineering and design processes is implemented by means of Federal Specifications, Interim Federal Specifications, and Federal Standards.

Public Law 152 requires full coordination among the supply activities of the military and civil agencies so as to avoid conflicts and duplication. Upon signing the act into law, the President on July 1, 1949, directed the

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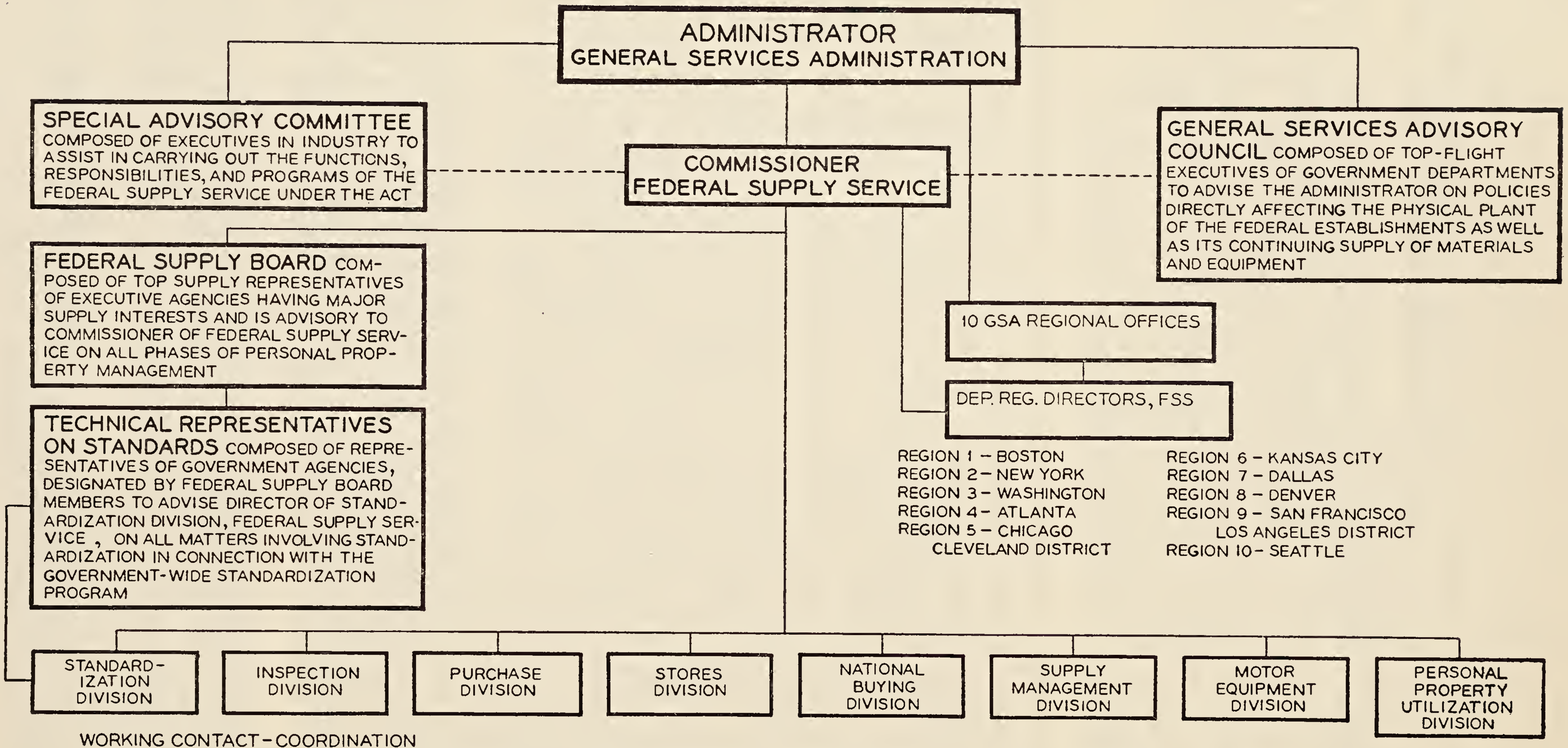
[2] Appendix B, January 1949, p. 83.

[3] For details of the functions and activities of supply which are related to standards see Section 101.00, GSA Manual GS 2-1.

[4] Section 501.00, Part 5, Chapter III, GSA Manual GS 2-1.


ADMINISTRATOR
GENERAL SERVICES ADMINISTRATION
SPECIAL ADVISORY COMMITTEE COMPOSED OF EXECUTIVES IN INDUSTRY TO ASSIST IN CARRYING OUT THE FUNCTIONS, RESPONSIBILITIES, AND PROGRAMS OF THE FEDERAL SUPPLY SERVICE UNDER THE ACT
COMMISSIONER
FEDERAL SUPPLY SERVICE
GENERAL SERVICES ADVISORY COUNCIL COMPOSED OF TOP-FLIGHT EXECUTIVES OF GOVERNMENT DEPARTMENTS TO ADVISE THE ADMINISTRATOR ON POLICIES DIRECTLY AFFECTING THE PHYSICAL PLANT OF THE FEDERAL ESTABLISHMENTS AS WELL AS ITS CONTINUING SUPPLY OF MATERIALS AND EQUIPMENT
FEDERAL SUPPLY BOARD COMPOSED OF TOP SUPPLY REPRESENTATIVES OF EXECUTIVE AGENCIES HAVING MAJOR SUPPLY INTERESTS AND IS ADVISORY TO COMMISSIONER OF FEDERAL SUPPLY SERVICE ON ALL PHASES OF PERSONAL PROPERTY MANAGEMENT
10 GSA REGIONAL OFFICES
DEP. REG. DIRECTORS, FSS
TECHNICAL REPRESENTATIVES ON STANDARDS COMPOSED OF REPRESENTATIVES OF GOVERNMENT AGENCIES, DESIGNATED BY FEDERAL SUPPLY BOARD MEMBERS TO ADVISE DIRECTOR OF STANDARDIZATION DIVISION, FEDERAL SUPPLY SERVICE, ON ALL MATTERS INVOLVING STANDARDIZATION IN CONNECTION WITH THE GOVERNMENT-WIDE STANDARDIZATION PROGRAM
REGION 1 – BOSTON
REGION 2 – NEW YORK
REGION 3 – WASHINGTON
REGION 4 – ATLANTA
REGION 5 – CHICAGO
CLEVELAND DISTRICT
REGION 6 – KANSAS CITY
REGION 7 – DALLAS
REGION 8 – DENVER
REGION 9 – SAN FRANCISCO
LOS ANGELES DISTRICT
REGION 10 – SEATTLE
STANDARDIZATION DIVISION
INSPECTION DIVISION
PURCHASE DIVISION
STORES DIVISION
NATIONAL BUYING DIVISION
SUPPLY MANAGEMENT DIVISION
MOTOR EQUIPMENT DIVISION
PERSONAL PROPERTY UTILIZATION DIVISION

WORKING CONTACT–COORDINATION
EXECUTIVE AGENCIES; SUPPLIERS-MANUFACTURERS; TECHNICAL SOCIETIES AND ASSOCIATIONS; TRADE ASSOCIATIONS

NOTES: BY DIRECTIVE JUNE 22, 1955, THE ADMINISTRATOR ESTABLISHED THE TRANSPORTATION AND PUBLIC UTILITY SERVICE – CONSOLIDATING FSS TRANSPORTATION AND PUBLIC UTILITIES DIVISION, AND EPS SHIPPING BRANCH OF STORAGE AND SHIPPING DIV. NATIONAL BUYING DIVISION ESTABLISHED AUGUST 24, 1955, BY TRANSMITTAL LETTER NO. 28 TO GSA MANUAL GS 2-1.

JAN. 18, 1956

Chart 21–1. General Services Administration—Organization for Standardization in Supply.

Director of the Bureau of the Budget, the Secretary of Defense, and the Administrator of General Services to "forthwith undertake, and diligently pursue, studies aimed at developing areas of understanding with respect to the extent to which the National Military Establishment should be exempt from the jurisdiction of the Administrator . . ." under the applicable provisions of the act and "present any appropriate recommendations to the President."[5]

The President also directed that pending the outcome of such determination or without his prior approval the Secretary of Defense should not exempt himself from the provisions of the act or from actions taken by the Administrator under the authorities provided.

Accordingly, areas of understanding and working arrangements were developed in 1951 between the General Services Administration and the Department of Defense.[6] Subsequent enactment in 1952 of the Defense Cataloging and Standardization Act (Public Law 436, 82nd Congress) made mandatory a standardization program in the Department of Defense.

This law also required the Administrator of General Services and the Secretary of Defense to coordinate the cataloging and standardization activities of their agencies so as to avoid duplication. The President subsequently determined that the Areas of Understanding Agreement was no longer needed and therefore rescinded it by directive.[7] The policies and principles enunciated are still largely being adhered to in day-to-day working arrangements.

The actions culminating in Public Laws 152 and 436, and the need for a highly accelerated supply program, pointed up the need for accompanying acceleration in the issuance of Federal Standards and Federal Specifications. For years Federal Specifications were developed by seventy-eight technical committees operating under the general supervision of the Federal Specifications Board. The committee roster showed over 700 technicians holding close to 1300 committee memberships. The committee procedure and agency coordination were of necessity time-consuming.

To overcome this, and at the same time take full advantage of the technical know-how of the agencies' technical staffs, the assigned-agency method of developing Federal Specifications was adopted. (See Chart

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[5] Joint memorandum to the Director of the Bureau of the Budget, the Secretary of Defense, and the Administrator of General Services, dated July 1, 1949, signed by President Harry S. Truman.

[6] Areas of Understanding Agreement Between the GSA and the Department of Defense with Respect to Standards, Specifications, Packaging, and Inspection, dated November 7, 1951, signed jointly by the Chairman, Munitions Board, DOD; Administrator of General Services; and the Director of the Bureau of the Budget.

[7] Joint memorandum to the Director of the Bureau of the Budget, the Secretary of Defense, and the Administrator of General Services, dated June 8, 1954, signed by President Dwight D. Eisenhower.

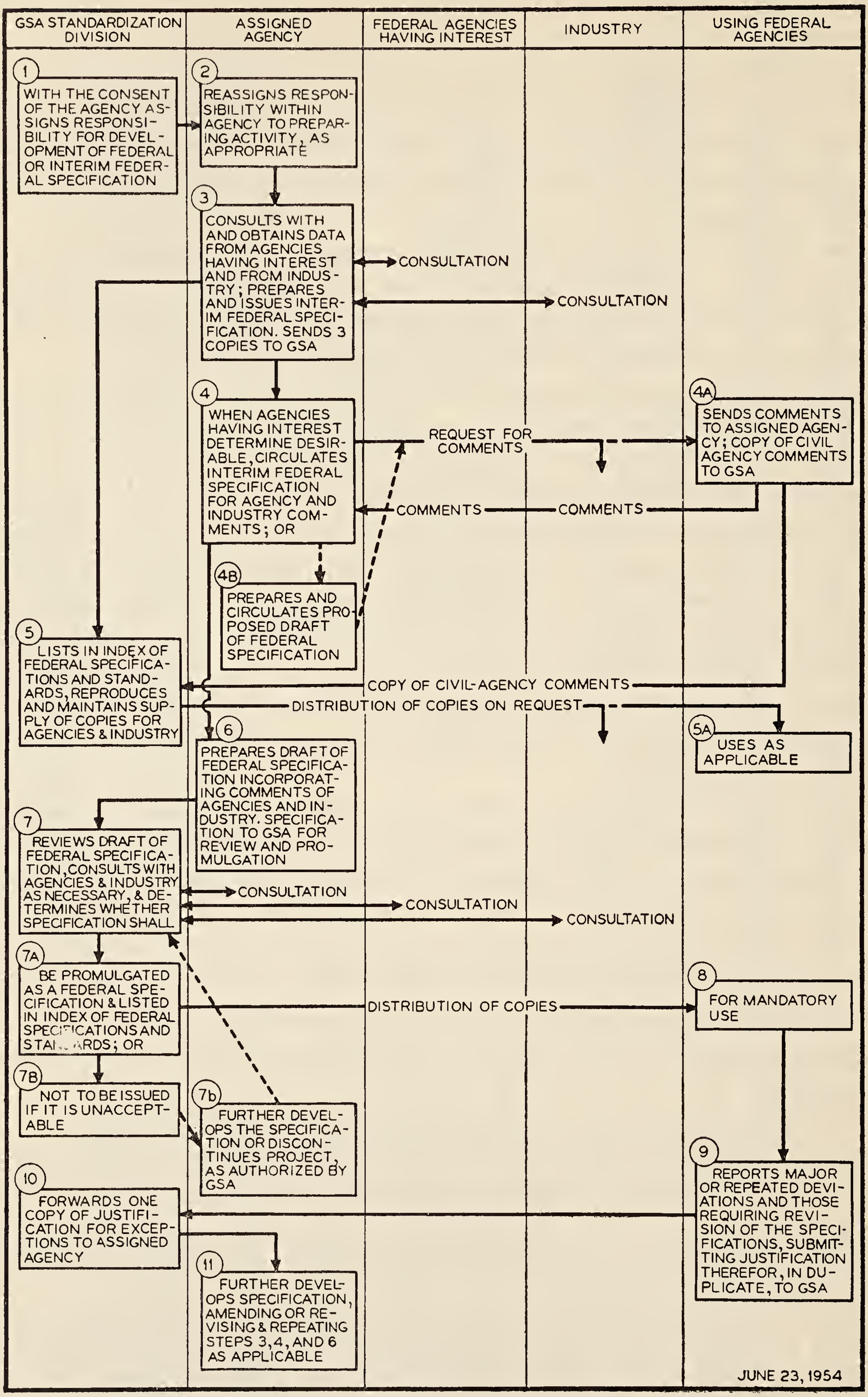
GSA STANDARDIZATION DIVISION
ASSIGNED AGENCY
FEDERAL AGENCIES HAVING INTEREST
INDUSTRY
USING FEDERAL AGENCIES
1
WITH THE CONSENT OF THE AGENCY ASSIGNS RESPONSIBILITY FOR DEVELOPMENT OF FEDERAL OR INTERIM FEDERAL SPECIFICATION
2
REASSIGNS RESPONSIBILITY WITHIN AGENCY TO PREPARING ACTIVITY, AS APPROPRIATE
3
CONSULTS WITH AND OBTAINS DATA FROM AGENCIES HAVING INTEREST AND FROM INDUSTRY; PREPARES AND ISSUES INTERIM FEDERAL SPECIFICATION. SENDS 3 COPIES TO GSA
CONSULTATION
CONSULTATION
4
WHEN AGENCIES HAVING INTEREST DETERMINE DESIRABLE, CIRCULATES INTERIM FEDERAL SPECIFICATION FOR AGENCY AND INDUSTRY COMMENTS; OR
REQUEST FOR COMMENTS
4A
SENDS COMMENTS TO ASSIGNED AGENCY; COPY OF CIVIL AGENCY COMMENTS TO GSA
COMMENTS
COMMENTS
4B
PREPARES AND CIRCULATES PROPOSED DRAFT OF FEDERAL SPECIFICATION
5
LISTS IN INDEX OF FEDERAL SPECIFICATIONS AND STANDARDS, REPRODUCES AND MAINTAINS SUPPLY OF COPIES FOR AGENCIES & INDUSTRY
COPY OF CIVIL-AGENCY COMMENTS
DISTRIBUTION OF COPIES ON REQUEST
5A
USES AS APPLICABLE
6
PREPARES DRAFT OF FEDERAL SPECIFICATION INCORPORATING COMMENTS OF AGENCIES AND INDUSTRY. SPECIFICATION TO GSA FOR REVIEW AND PROMULGATION
7
REVIEWS DRAFT OF FEDERAL SPECIFICATION, CONSULTS WITH AGENCIES & INDUSTRY AS NECESSARY, & DETERMINES WHETHER SPECIFICATION SHALL
CONSULTATION
CONSULTATION
CONSULTATION
7A
BE PROMULGATED AS A FEDERAL SPECIFICATION & LISTED IN INDEX OF FEDERAL SPECIFICATIONS AND STANDARDS; OR
DISTRIBUTION OF COPIES
8
FOR MANDATORY USE
7B
NOT TO BE ISSUED IF IT IS UNACCEPTABLE
7b
FURTHER DEVELOPS THE SPECIFICATION OR DISCONTINUES PROJECT, AS AUTHORIZED BY GSA
9
REPORTS MAJOR OR REPEATED DEVIATIONS AND THOSE REQUIRING REVISION OF THE SPECIFICATIONS, SUBMITTING JUSTIFICATION THEREFOR, IN DUPLICATE, TO GSA
10
FORWARDS ONE COPY OF JUSTIFICATION FOR EXCEPTIONS TO ASSIGNED AGENCY
11
FURTHER DEVELOPS SPECIFICATION, AMENDING OR REVISING & REPEATING STEPS 3, 4, AND 6 AS APPLICABLE
JUNE 23, 1954

Chart 21–2. Development of Federal and Interim Federal Specifications.

21-2.) This procedure provides that specifications projects be assigned to a specific agency, with its consent, with full responsibility for the technical development. Government and industry coordination rests with that agency.

The Standardization Division staff is responsible for supervising and correlating the projects, negotiating assignments and assisting in the general development of the specification projects. It also acts as an assigned agency for certain standards projects which it can handle more effectively than other agencies.

The Federal Specifications Board and its technical committees were abolished April 22, 1952, and interagency consultation and advice is now provided by the Technical Representatives on Standards of the Federal Supply Board.[8]

The Federal Supply Board advises the Commissioner of Federal Supply on all broad supply matters and the Technical Representatives in turn advise the Director of the Standardization Division on technical standards matters. Chart 21-1 illustrates this organizational relationship.

It is obvious that the military and civil agencies' standardization programs cannot be effective without close cooperation with industry. To this end close working relationships are maintained with the American Standards Association and technical societies and associations typified by the American Society for Testing Materials, the Underwriters' Laboratories, the National Electric Manufacturers Association, to mention but a few. These groups have been valuable contributors to the government's standardization program.

A gauge of the significance of standards as they affect industrial production and its economy will be gained from the fact that the federal government is the world's largest single consumer. GSA alone in fiscal year 1954 made federal purchases of well over a billion dollars. Over $900 million was spent in purchases for the national stockpile and special aid programs. The balance of slightly less than $400 million was expended for items in common use by military and civil agencies. The items included operational and administrative supplies and equipment necessary to service the program needs of the various agencies.

To the sums expended by General Services Administration must be added the direct purchases by civil and military agencies involving several billions of additional demand on the productive economy. Total government expenditures for supplies and equipment alone in fiscal year 1954 approximated $20 billion.

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[8] General Services Administration Circular No. 44, dated April 22, 1952, to the Heads of Federal Agencies, signed by Jess Larson, Administrator.

Government Standards—Extent, Variety, Purpose

In servicing the Federal Supply System with the standards it needs, use must be made of all available types of specifications. The specification must be a complete procurement document, defining the character of the item required, the test and inspection methods and procedures, methods of sampling, quality assurance, shipping instructions, and packaging and marking. As in all sound specifications the materials user must be given information dealing with the scope and use of the items specified.

It may be well to discuss briefly the various types of specifications and standards. These include performance, construction, materials, and packaging specifications; and engineering and technical limitations and applications for materials, processes, methods, designs, drafting room, and other engineering practices.

Wherever possible, and ideally, use is made of *performance specifications*. This is in order to allow the supplier the widest possible latitude in design, construction, and manufacture and at the same time provide a means of comparison for purposes of award in terms of cost-serviceability ratios.

To illustrate, Federal Specification W-F-101b covers performance requirements of 10″, 12″, and 16″ bracket and desk electric fans. Performance is stipulated on the basis of the fan's moving air within a range of low to maximum speed at minimum thrust, power input, and noise levels. Use is made of applicable performance required by Underwriters' Laboratories and the American Standards. A manufacturer may qualify the performance of his product by test in a government laboratory, an approved commercial laboratory, or approval of his own laboratory. This provides the procurement officer an easy basis on which to evaluate the bids received. It then follows that the lowest price bid offers the best value under the specification requirements. The government thus makes the best buy.

Many attempts have been made to establish adequate specifications for slip-resistant, water-emulsion floor wax. Industry, the American Society for Testing Materials, the Underwriters' Laboratories, and the National Bureau of Standards have long sought laboratory means of measuring the performance of floor waxes. In the past, several specifications outlining composition and measures of slip-resistance certification have failed to provide a basis upon which contracts could be awarded for a high quality product.

Federal Specification P-W-155 solves this problem by prescribing tests of manufacturers' products in comparison with a standard sample against which the performance characteristics of slip-resistance and durability, a measurement of total solids, limitation of sediment, stability, removability, water spotting, and odor are measured. A Qualified Products List has been established based upon comparative qualifying tests at several locations by several examiners independently scoring the performance characteristics of the waxes. A basis is thus provided upon which a score sheet evaluation determines acceptability of the product.

Water-emulsion floor waxes are now being obtained which offer two or three times more serviceability and, therefore, potentially lower maintenance costs of the floors. Two grades are being supplied (1) 12 per cent of solids for normal light floor traffic, and (2) 16 per cent of solids for heavy traffic. The safety factor of slip-resistance is a primary element of the performance; durability and protection of the floor, the secondary element.

Many items of supply must be specified on the basis of *construction specifications.* This is so because of the character of the item itself or because adequate test methods to measure performance of end product items are unavailable or have not been developed. Fastening devices, such as cap screws and machine screws, are excellent examples of items reflecting construction characteristics. Dimensions, physical strength, and composition of material, together with the infinite varieties of head forms make it virtually impossible to set standards on the basis of application performance.

Stress-temperature limitations suffice to augment the dimensional physical, and compositional stipulations to form adequate specifications and standards. However, as in every "rule" there are exceptions. To determine service performance of steel, like bolting materials, tests may be applied as a supplement to specifying the normal characteristics. Examples are impact tests for low temperature bolts—short and long time (creep stress) high-temperature tension tests.

The Federal Specification for General Office Wood Chairs, developed to provide uniformity in construction and serviceability, provides for a straight-legged chair and a rotary swivel chair, with and without arms. The swivel chair is specified in two types, with tilting adjustable back and seat, and with tilting back only. Light oak and walnut finishes are standard and plastic or fabric upholstery are provided.

Requirements include specifications for the wood, the glues, hardware, glides and casters, rotary mechanisms, upholstery, and detail designs establishing a serviceable, low-cost standardized chair, consistent with the products made by representative suppliers, geographically located.

Materials specifications require no definition and are typified by specifications covering alloy steel bars, carbon steel plate, masonry and Portland cements, photographic acetic acid, thermal insulation felt, and battleship linoleum.

The importance of *packaging specifications* to supply operations is illustrated by the fact that damage to goods in transit has always constituted a tremendous monetary loss to the American economy. In one year alone, it is related, "the railroads of the United States paid back to shippers claims for loss and damage on freight amounting to $113,844,712, which is equivalent to $1.53 on every $100 of revenue. . . . It is estimated that the total losses of all carriers and refused claims are about $225,000,000. . . ."[9] Not only would these direct costs of damage in shipment be materially reduced through improved packaging but, equally important, a large potential saving would result from the lower shipping and storage costs brought about by more efficient loading volumes and higher storage space utilization.

Development of a full-scale set of packaging specifications for the vast number of items of supply involved in the Federal Supply System has been hampered by the wide industrial variations in packaging and the many different conditions of shipping, storage, and use which must be satisfied. However, both federal and military specifications have been developed covering general requirements for packaging and specific types of packing and packaging materials, such as wrapping, bags, pallets, boxes, cartons, drums, tapes, tubes, and paper.

For example, Interim Federal Specification PPP-P-0051 covers the packaging, packing, and marking of textiles (woolens, worsteds, cotton, silk, and synthetic fabrics). Interim Federal Specification PPP-P-0032 covers the preservation, packaging, packing, and marking of materials, as well as shipping instructions (domestic shipments for immediate use).

A significant development in the packaging policy of the government was the General Services Administration Agreement with the Department of Defense on the following levels of packaging and packing requirements:

Domestic, immediate use—Applies to the material required for immediate use, without storage or reshipment by the initial domestic receiving activity.

Domestic, storage—Applies to the material for multiple domestic shipment, handling, and storage, not involving sea transportation.

Commercial, export (non-military, overseas)—Applies to the material to be transported by ocean-going vessel, accorded normal covered storage at destination, and involving items which are to be used at the initial receiving activity.

Military, overseas—Applies to the material to be shipped, handled, and stored in the military supply system for world-wide distribution and undetermined storage conditions.

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[9] R. J. Bisbee, "Methods of Evaluating Savings from Standardization," *The Philadelphia Purchaser,* Vol. XXVII, no. 2 (February 1952), p. 34.

The General Services Administration regulations contain the following requirement:

> The preservation, packaging, packing, and marking requirements in specifications shall be uniform to the greatest extent practicable consistent with the varying needs of Federal agencies for domestic and export shipments. Such requirements shall be adequate but not in excess of the level of protection necessary to assure delivery and storage of supplies in a satisfactory condition, with the greatest practicable conservation of man power, materials, and money. . . .[10]

This requirement plus the agreement quoted above will result in great savings to the government in connection with the shipment of federal supply items.

Federal Standards establish engineering or technical limitations and applications for materials, processes, methods, designs, drafting room, and other engineering practices, in order to reach the highest degree of uniformity practicable.

Through June 30, 1955, General Services Administration had issued 70 Federal Standards: 3 cover methods, 6 are engineering and process, 59 are limitation, and 2 application standards. (See Table 21-A.) The standardization effort has been concentrated on the preparation of the limitation type of standard because it yields direct economies and effectiveness in the supply system. The 59 limitation standards issued establish the standard items which are permitted to be procured by all agencies of government. These cover such goods as paper products, soaps, office supplies, office furniture, electric fans, foodstuffs, and textile domestics.

These limitations standards involved 2230 items in the supply system at the outset of the standardization studies. The number of items was reduced through standardization to 330. This achievement in reducing variation is drastic and undoubtedly represents a high degree of austerity. It is safe to estimate that an over-all average reduction of 50 per cent of the items in the Federal Supply System can be made through standardization.

To illustrate the possibilities in this direction, there were in use 113 items in 5 types, 3 basis weights, 15 sizes and 8 colors of mimeographed paper. The standardization resulted in a reduction to 17 items in 2 types, 2 basis weights, 7 sizes, and 6 colors. In the case of paper towels a Federal Standard adopted 7 items and eliminated 11. Executive office wood chairs were reduced from 18 to 4 items. There are now 5 items of typist's chairs in the supply system as contrasted with 29 formerly stocked.

Application standards for office furnishings, filing cabinets, regular and

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[10] Section 202.03, Part 2, Chapter VI, Title 1, Personal Property Management, Regulations of the General Services Administration.

TABLE 21-A. DISTRIBUTION OF SPECIFICATIONS AND STANDARDS PROMULGATED UNDER GROUPS FOR PROCUREMENT
(*As of June 30, 1955*)

Group		Federal	Interim federal	Federal standards	GSA	Federal qualified products lists
C	Animal products	26	2		1	
D	Arms (small)		6			
F	Boilers, engines, and tanks	2	3			1
G	Books and printed matter	7	1			
H	Brooms and brushes	76	3		2	
J	Cable and wire (insulated)	9	3			
K	Canvas articles	5			1	
L	Cellulose products and synthetic resins	34	4			
M	Ceramics	1				
N	Cereals and products	29	3			
O	Chemicals	154	32		1	4
P	Cleaning and polishing materials	53	18	6	1	7
Q	Coal and products	2				
R	Coal tar and products	4	2			
S	Cooking and heating apparatus, furnaces, and ovens (nonelectric)	2				
T	Cordage, twine, and products	19	1		3	
U	Drugs and medicines	25				
V	Dry goods and notions	10				
W	Electric apparatus	82	27	3	6	7
X	Explosives		2			
Y	Fruits	34	3			
Z	Fruit products	45	3			
AA	Furniture	65	18	26	4	
BB	Gases	8				
CC	Generators and motors	2	1		1	
DD	Glass and glassware	63	3	1		
EE	Groceries	21	2			

FF	Hardware	52	9	2	4	2
GG	Instruments	274	24	1	6	1
HH	Insulating materials	71	3		3	
JJ	Knit goods, netting, and webbing	21	1			
KK	Leather and leather goods	33	12		1	
MM	Lumber and timber	3	1			
NN	Lumber products	16				
OO	Machinery	45	20		5	1
PP	Meats and sea foods	57	8			
QQ	Metals	162	21		1	
RR	Metal products	104	17	1	3	
SS	Minerals and products (nonmetallic)	100	10	1		
TT	Paints, pigments, varnishes, and products	178	14		4	5
UU	Paper and products	96	23	10	6	
VV	Petroleum and products	32			1	1
WW	Pipe, pipe fittings, plumping fixtures, tubes, and tubing (metallic)	49	2			
XX	Pumps	1			1	
ZZ	Rubber and rubber goods	98	6	2	4	
AAA	Scales	15				
BBB	Suits and uniforms	7	1			
CCC	Textiles (yardage)	60	4		4	
DDD	Textile products	89	9	4	7	
FFF	Toilet articles	3				
GGG	Tools	149	42		9	11
HHH	Vegetables	47	3			
JJJ	Vegetable products	49	4	1	1	
KKK	Vehicles	10	7		6	
LLL	Wood products	38	3	1	1	
MMM	Adhesives	3	1			
PPP	Packaging and packing	13	14			
	Totals	2,653	396	59[a]	87	40

[a] Actual total is 70 Federal Standards which includes 3 methods, 6 engineering and process, 2 application, and 59 limitation standards.

premium gasoline, and electric typewriters are established in GSA Regulations on the Utilization of Government-owned Personal Property.[11] They set usage controls on the commodities listed. The technical elements of application standards will be covered in future issues of Federal Standards.

Engineering and process standards have been established for tolerances for steel and iron wrought products and for chemical composition and hardenability of steel.

Federal Specification TT-C-595 sets standard colors for ready-mixed paints. A general revision of the specification is being printed for issuance as a Federal Standard. While designed to establish standard colors for paints, the system is used extensively for other types of materials, such as textiles, to set the basic color required. There are 358 flat, semigloss, and gloss finishes of 199 colors. The standard color book is supplemented by separate 3″ x 5″ chips to be used as prototype standards for matching in procurement, receiving, and inspection.

Methods are also covered in the Federal Standards series. Federal Standard test methods for sampling and testing rubber have just been issued. Present specifications covering test methods for petroleum products and textiles are now under revision for issuance as Federal Standards. Federal Standard No. 1 sets uniform laboratory atmospheric conditions for testing. Previously a wide variety of conditions of temperature and humidity were specified in the Federal Specifications depending upon the commodity covered.

The last type of Federal Standard in the category of practices provides guidance to federal agencies in the maintenance of existing equipment, and replacement policy. As in application standards, the technical elements will be included in Federal Standards and application to supply functions will be included in the regulatory material covering utilization.[12] At present, replacement standards have been established for motor vehicles, typewriters, and office furniture.

Much more needs to be done to provide replacement standards for varying large-use-volume items of supply. The scope of such standards taken in combination with application standards involves full consideration of the applications of the equipment, the frequency of its actual use, and taking advantage of all the operations which a machine or equipment will perform.

The purpose to be served by the several types of standards being developed is to assure that standard items of supply are used in that service application which will yield the greatest return in effective service for the dollars spent. For example, when should an electric typewriter be used instead of a manual and at what age and condition should it be replaced? What are the conditions of use for which each standard quality of carbon paper will give best results?

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[11] Section 204.01, Part 2, Chapter III, Title 1, Utilization of Government-owned Personal Property, Regulations of General Services Administration.

[12] *Idem.*

Very little has been done on recommended practices. They involve the preparation of manuals, handbooks, and instructive material dealing with the characteristics and applications of materials, supplies, and equipment. An excellent handbook on materials handling has been produced by the Federal Supply Service. A few pamphlets have been prepared providing useful information on such materials as janitorial supplies, paints, and job maintenance practices of the Public Buildings Service. Instructions have also been provided to agencies through circular letters of the General Services Administration. Staff and funds have not been available for formulation of a specific program covering use-application information pamphlets.

CATALOGING

No discussion of a standardization program would be complete without reference to the importance of *item identification and commodity classification.* A catalog system is essential to efficient supply management and operation. It classifies,[13] identifies, and uniformly numbers each line supply item in a systematic arrangement. It establishes a basis on which to conduct efficient determination of procurement requirements; a simple and orderly method of warehousing and inventory control; the distribution and use of supplies and equipment; and, an orderly means of dealing with the disposition of excess stocks or surpluses.

The identification of each item in the supply system through a uniform and clear description and item number, and classification of the items into related groups or classes establishes a uniform language and clear understanding of each item in the supply chain. Such a supply catalog system is designed to serve the following functions of supply:

1. Standardization and simplification of supply items.
2. Facilitating the selection of standard items in research and design activities.
3. Establishing levels of requirements.
4. Procurement and organization of purchase assignments.
5. Production and supply-demand planning.
6. Orderly inventory control.
7. Materials inspection.
8. Shipping.

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[13] Federal Supply Classification, Part 1, groups and classes, Cataloging Handbook H2-1; Part 2, Numeric Index of Classes, Cataloging Handbook H2-2; Part 3, Alphabetic Index, Cataloging Handbook H2-3.

9. Receiving.
10. Storage.
11. Requisitioning and issue.
12. Determining interchangeability and substitutability.
13. Maintenance and repair parts relation to parent item.
14. Utilization of property, redistribution of excess, and disposal of surplus.
15. Accounting, budgeting, and supplies allotment controls.

The interrelationships of civil and military cross-supply servicing require that the common language of the Federal Catalog System be utilized by all agencies of the government. Unless civil agency items used in common with the military and those exclusively used by civil agencies are brought into the system, it will be increasingly difficult to achieve the mutual benefits of inter-civil-military supply support. Furthermore, civil agency supply operations cannot be based on the uniform Federal Catalog System until all civil items are included.

For almost forty years attempts have been made, largely by the military services, to identify supply items used by them in cataloging systems. During this period the technical services within the military departments and a few civil agencies developed seventeen uncoordinated catalog systems to meet their supply requirements. The most commonly known and used system was the Federal Standard Stock Catalog covering about 360,000 common supply items.

World War II and its aftermath of surplus disposal pointed up the vital need for a uniform supply language which would (1) assign one name, one number, and one description to each supply item so that it would be uniquely identified, and (2) be used by all agencies of the federal government whether military or civil in all functions of supply management from determination of requirements to final disposal.

The first Hoover Commission urged the establishment of a central supply system. It emphasized the essentiality of providing a uniform federal catalog system for supply management. This recommendation, as we know, culminated in the enactment of Public Law 152.

By joint effort the General Services Administration and the Department of Defense developed the methods, procedures, and "production tools" for uniform item identification in the Federal Catalog System. Under a delegation of authority by the Administrator to the Secretary of Defense, the development of the catalog system by military agencies got actively underway in 1949. A part of the civil agency identifications was produced by GSA under this joint working arrangement in 1951 and 1952, but the civil area cataloging had to be discontinued when Congress denied funds for the work.

The second Hoover Commission recommended in 1955 that the Secretary of Defense for his Department, and the Administrator of General

Services for all civilian agencies closely supervise the federal catalog program to insure its completion and use at the earliest possible date. It further recommended that a master plan be formulated by the Secretary and the Administrator for integrating the catalog system into all aspects of supply management. These recommendations were made as a result of a property utilization study in which it was indicated that vast improvements can be made in inventory flexibility and excess property utilization.

Department of Defense has scheduled completion of the identification of military supply items by the fall of 1956, with full conversion to the Federal Catalog System (which now includes only the items used by the military) by the end of 1958. To complete the civil agency portion of the program, for which budget has not yet been made available, as nearly simultaneously as possible with the military will require the identification of about 900,000 civil agency items over a period of four years.

To identify a single item in the Federal Catalog System all present civil agency identifications for that item must be compared with that of the military item to determine whether they are identical. Where it is not the item identified by the military, it is cataloged as a "solely civil" item. In some cases this might mean the comparison of the differently described characteristics of similar items from as many as twenty major civil agencies or subdivisions before it can be determined whether or not they are identical.

The civil agency portion includes an estimated 425,000 solely civil agency items, and an estimated 700,000 joint-use civil and military items, or a total of 1,125,000. The military portion includes 2,025,000 military science and combat items in addition to an estimated 700,000 items jointly used by civil and military agencies, a total of 2,725,000. Taking into account an estimated shrinkage of perhaps 222,650 civil agency items accomplished by standardization or acceptance by civil agencies of the military item or vice versa, there remain 902,350 civil items to be included in the Federal Catalog System.

The military departments will have described an estimated 700,000 items which may be used by both military and civil agencies. To determine whether an item described by a military service is the same as a civil item, these steps are generally required:

1. Determine from data submitted by a civil agency the group and class of commodities in which the item should be placed.
2. Determine whether the item name used by the civil agency is the approved item name. (The civil agency item name might be bushing, plain, flanged; or, sleeve flanged; whereas the approved item name is bearing, plain [flanged].)
3. Select the appropriate description pattern for the approved item name.

(A description pattern is a formula by which all similar items are uniformly described.)

4. Using the civil agency data, record in the sequence of the description patterns all the characteristics of the civil agency item.
5. Select an item identified by the military departments which appears the same as the item of the description produced in (4). If the military item is identical with that described in (4), then the military number is adopted for the civil agency item. Until the foregoing steps are completed, a determination cannot be made whether the item is, or is not, a common-use item.
6. If as a result of the foregoing steps no comparable military item can be found, a new Federal Catalog System number is assigned to the item.
7. As homogeneous groups and classes of items are completed, pamphlets will be printed showing the Federal Catalog System number and identification, cross-referenced to the number which the civil agency previously used.
8. At this point, agencies will convert groups and classes completed to the Federal Catalog System numbers and identifications. Existing stocks will not be re-marked and, for a short period of time, old and new numbers will be used in the transition to the new system. After that time the Federal Catalog System nomenclature and number will be used exclusively.

The importance of cataloging to effective supply has been brought to the attention of the committees of the Congress with a recommendation that funds be made available with which to bring into the catalog system, along with those of the military, the civil agency supply items.

Provision has been made for the cataloging in the Federal Catalog System of the items GSA procures (130,000) by June 30, 1957. Funds will have to be provided to catalog the balance of civil agency items in subsequent years.

The results which are to be expected from the uniform catalog system[14] in the federal government are:

1. Reduction in the number of varieties, types, and sizes of similar items; the elimination of duplicates and of specials.
2. Establishment of a uniform language of supply, simplifying administration, and eliminating misunderstanding.
3. Increased purchase volume and lower unit cost by concentrating purchases on fewer items.
4. Reduction in stock inventories and increased rate of turnover.
5. Better supplies and equipment through standardization made possible by uniform identification.
6. Greater vendor competition and broader sources of supply through concentration on the uniform list of supply items; better utilization of supplies and equipment, and excess stocks; and the more orderly disposal of surplus and obsolete stocks.

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[14] For a detailed discussion see Robert L. Totten, "Supply Cataloging, Its Objectives, Elements and Procedures," *Standards World,* Vol. II, no. 1 (January 1950), pp. 41-58.

7. Lastly, easier determinations of interchangeability and substitutability of items.

It is the policy of the General Services Administration *to inspect* all materials, supplies, and equipment for compliance with contract requirements prior to acceptance and payment for them.

This is to be accomplished in the most economical manner and with the least interference practicable with the processes of suppliers and distributors, while at the same time adequately protecting the government from accepting material not complying with the contract specifications.

Economical inspection is accomplished by taking into consideration many variables inherent in each commodity and in each purchase transaction. Several of these variables are: the value of the material; the quantity in the inspection lot; the type of material; its effect on health or property; the distribution to be made to one or more GSA supply warehouses; perishability of items; or conditions of production. These variables determine where the material should be inspected: at point of manufacture or at the government receiving point.

Inspection in GSA is primarily end-product inspection. It is expected that the supplier will establish necessary controls to assure himself that the end product offered will comply with the specifications. In no case will the GSA inspector conduct his work so as to eliminate the contractor's inspection of his product. The contractor's inspection control, however, will be taken into consideration in determining the extent of GSA inspection and its consequent effect on production and immediate acceptance or rejection of the finished product. The testing laboratory maintained by a supplier and its effectiveness in assuring production of material of contract quality determine to a considerable extent how confident the government is that it will receive goods of specified quality.

When there is no such production control, it is necessary for the government to select representative samples of each lot of material and send them to a laboratory for test prior to acceptance. Eight acceptance testing laboratories have been set up in GSA regional warehouses at New York City, Washington, Atlanta, Chicago, Kansas City (Missouri), Dallas, San Francisco, and Seattle. The laboratories are staffed by qualified technicians and provided with the necessary equipment to perform the spot tests required for the determination of quality of deliveries.

The acceptance testing laboratories of GSA are staffed and equipped to test most items of common use, but not to conduct all tests desired on all items. When such tests are necessary, the facilities of another government laboratory or a qualified commercial laboratory are used. The National Bureau of Standards, Bureau of Customs, Reclamation Bureau, Bureau of Mines, and Army and Navy laboratories have been called upon at various times for assistance.

The services of more than fifty commercial laboratories have also been used and will continue to be used when it is more economical to contract for the infrequent test work requiring equipment of high cost and technicians of special competence.

Quality assurance inspection is a measure of a contractor's ability to supply material which will, beyond a reasonable doubt, comply with the contract specification requirements. Quality assurance is not based solely on the inspection of the finished product but on a combination of factors in addition, which constitute acceptable evidence that the contractor can supply a finished product fully complying with the specification. Intermittent inspection of the finished product is then necessary only to verify that the product does comply. Company certification of compliance with contract specification requirements may then be considered as a proper element in determining whether supplies or services conform to the contract.

Basic requirements necessary to apply this type of inspection are:

1. The product must be a manufactured or fabricated product and not raw material.
2. The company must maintain adequate in-process quality control.
3. The company must maintain an adequate inspection system including inspection of incoming material; testing in a company laboratory or a commercial laboratory as required; in-process inspection; finished product inspection; and packing, marking, and loading inspection.
4. The company must maintain adequate quality control and inspection records to permit verification by a government inspector of compliance with contract specifications.
5. The integrity and reliability of the contractor to supply specification material as measured by: past performance; standing and reputation in industry; and general housekeeping practices.
6. Other factors which may be taken into consideration are: pre-production samples; Qualified Products Lists certification; Quality Level certification; company inspection and testing manuals; and statistical quality control procedures.

This procedure has been used with considerable success and has made it possible to reduce GSA inspection costs by more than 50 per cent in approximately thirty plants where it is now being used.

Type and Volume of Federal Procurement

A better understanding of intragovernment relationships with respect to standards, discussed in the following section, will be gained if the scope and volume of procurement are briefly reviewed. Purchases of the federal government involve virtually all types of commodities. (See Table 21-B.) They include such items as textiles and clothing, fuels,

TABLE 21-B. LIST OF FEDERAL STANDARDS
(*As of June 30, 1955*)

Number	*Title*
1	Laboratory Atmospheric Conditions for Testing
2	Coal, Pennsylvania Anthracite
3	Colors, Aeronautical Lighting
4	Glossary of Fabric Imperfections (Section 1)
5	Standard Guides for Preparation of Item Descriptions by Government Suppliers
6	Paper, Toilet Tissue
7	Towels, Paper
8	Paper, Blotting
9	Paper, Computing-Machine
10	Soap, Toilet (Floating, White)
11	Soap, Toilet (Cake, Milled)
13	Soap, Toilet, Liquid and Paste
14	Soap, Toilet (Powdered, Dispensers)
15	Soap-Borax Powder, for Dispensers
16	Desks, Steel, General Office
17	Clips, Paper (Binder)
18	Clips, Paper
19	Pads, Desk
20	Cabinets, Metal, Storage
22	Costumers, Wood, General Office
23	Lockers, Clothing, Steel
24	Mirrors; Plate Glass, Framed
25	Settee, Wood, General Office
26	Stands; Dictionary, Wood
27	Stands, Typewriter, Wood
28b	Tray, Desk, Wood, General Office
29	Wardrobes, Wood, General Office
30	Chair, Bent Wood
31	Costumers, Metal, General Office
32a	Baskets, Wastepaper, Metal (Office and Lobby)
34	Basket, Wastepaper, Wood, Executive Office
35	Bookcases, Wood, Executive Office
36	Bookracks, Wood, Office
37	Cabinet, Telephone, Wood, Executive Office
38	Chairs, Wood, Executive Office
39	Costumer, Wood, Executive Office
40	Davenport, Executive Office
41	Desks, Wood, Executive Office
42	Tables, Wood, Executive Office
43	Tray, Desk, Wood, Executive Office
44	Wardrobe, Wood, Executive Office
45	Pencils, Lead (General Writing)
46	Paper, Mimeograph
47	Chair, Easy, Executive Office
48	Tolerances for Steel and Iron Wrought Products
49	Fans, Circulating, Column (Electric, Rigid-Blades Non-Oscillating, Not for Marine Service)
50	Fans, Electric; Bracket, and Desk-Types Rigid-Blades (for Shore Use)
51	Dishwashing Compound, Machine
52	Paper, Manifold
53	Paper, Bond and Writing, White
54	Pads, Memorandum
56	Beans, Dry
58	Sharpeners, Pencil
59	Sheet, Bed; Cotton (Bleached)
61	Pillowcases (Cotton Bleached)
62	Aprons, Bib, Cotton
63	Cover, Pillow
64	Rockers, Hand Blotter

TABLE 21-B. LIST OF FEDERAL STANDARDS—*Continued*
(*As of June 30, 1955*)

Number	*Title*	*Number*	*Title*
65	Fans, Circulating, Radial Discharge	82	Tables, Steel, General Office
66	Steel: Chemical Composition and Hardenability	83	(Int.) X-Ray Tube Focal Spot, Method of Measurement
67	Finger Pads, Rubber	85	Chairs, Rotary, Steel Tubular, Special Purpose
68	Rubber Bands	86	Filing Cabinets, Steel, Card Size (Desk Use)
72	Shockproof Cable Terminal and Receptacle for Use on X-Ray Equipment	87	Tables, Wood, General Office
76	Cassettes, Radiographic Film (Medical)	601	Rubber, Sampling and Testing (Fed. Test Method Standard)
			Total—70

vehicles, boats and marine equipment, mechanical and power generation equipment, electrical equipment and devices, instruments, rigging equipment, foods and feeds, tobacco products, furniture, floor coverings, sanitary supplies, insulating materials, office supplies and equipment, hardware, metal products, chemicals, paints, and hospital supplies.

Federal Supply Service meets the supply needs of federal agencies through various contractual and procurement arrangements. Essentially they are:

1. Master term contracts, known as Federal Supply Schedules, covering nearly 50,000 items, from which the agencies purchase direct.
2. Purchases by Federal Supply Service for stock and reissue to the agencies through 12 regional stores depots.
3. Consolidated purchases by Federal Supply Service of specified items for direct fixed-lot delivery to agencies.
4. Service purchasing for agencies on specific individual requirements.

During 1954 the Federal Supply Service provided the agencies through these contractual means with approximately $378 millions' worth of common-use supply items. This figure may be broken down into $275 million for Federal Supply Schedule purchases, $53 million for stores stock issue, and $50 million in consolidated and service direct delivery purchases. This involved the establishment of nearly 2500 Federal Supply Schedule contracts covering about 50,000 items in 90 commodity classes. The consolidated and service purchasing for direct delivery involved 135,000 line items. In addition to end-product items, annual term contracts are also let to provide agencies with service. These contracts cover repair and reconditioning of furniture, typewriters, wiping cloths, stenographic reporting, transportation, and the like.

As previously discussed, to this centralized supply service must be added the preponderant supply purchases of the military departments and the direct purchases of the individual civil agencies.

Intragovernment Relationships

Three levels of government standards are involved in its supply:

1. The Federal Specifications and Standards which are mandatory for use by all civil and military departments.
2. The Military Specifications and Standards which are applicable to military science and tactical items, and mandatory for use of the three military departments.
3. The Departmental Specifications and Standards which include the items not covered by a federal or military standard or specification.

In the last category are the individual departmental specifications of the Army, Navy, and Air Force, as well as those of civil agencies such as the Post Office Department and Veterans' Administration.

Under the coordinated civil-military standardization program, a special effort is being made to increase voluntary use among all federal agencies of those existing Military Specifications or Standards and Qualified Products Lists which cover common items, pending their future conversion to Federal Specifications or Standards. This is done through General Services Administration review and concurrence with the major using civil and military agencies, and listing the "adopted" military specifications in the Index of Federal Specifications and Standards.

To broaden the scope of this desirable objective, review has been made of key specifications of many of the major civil agencies in an effort to determine those meriting adoption as Federal Specifications. This will tend to limit multiple specifications for the same item.

Industry-Government Relationships

The broader aspects of the relationship between industry and government in the federal standardization program deserve analysis. The participation of industry and technical societies in the development of Federal Standards and Specifications has been previously covered.

In many categories there are no recognized standards and specifications dealing with end products. Consequently, Federal Specifications and Standards, supporting as they do the purchases of the world's largest single buyer, take on a national significance. For example, the Federal Specifications for hardware are recognized extensively by architects, engineers, and building contractors as "standard lines" of hardware.

The influence of the American Standards Association and of such technical societies and trade associations as the American Society for Testing

Materials and the National Electrical Manufacturers Association is of major significance. The American Standards approved by the ASA, and many of those developed by the societies and associations, reflect the consensus of engineering judgment of producers, distributors, users, and general interest elements. Deviations from or fundamental modifications of such standards by government introduce an important and often seriously disruptive "special." This negates the beneficial effect of the generally established industry standard or production practice standard. Thus, it is becoming increasingly evident that the technical societies, trade associations, and the federal government have a mutual stake in achieving correlated standards.

Standards developed by trade associations are an invaluable resource for the formulation of the more broadly accepted nationally recognized standards. The correlating facilities of such groups present an effective means of expediting this work. While many nationally recognized standards have been adopted in full in Federal Specifications, coordination between government and the societies in the development of standards must be more firmly established. The societies and associations must be more alert to the needs of the federal government, introducing promptly revisions or modifications in existing standards. On its part, the federal government must be more alert and specific in pointing out its needs for revision of the standards of societies and associations.

How to improve the industry-government relationship in regard to standards? The federal government has been over-cautious in formulating a forceful and uniform policy providing for the participation of government technical experts in the work of technical societies and associations. A recent survey shows that about 468 government technicians from 21 federal government agencies hold 585 liaison representations on technical committees of the American Standards Association. The Department of Defense is by far the largest participant. A similar count by the American Society for Testing Materials would undoubtedly show an equally large number of government representatives participating in the committee activities of the Society.

From ASA's early formation until July 1948, government officials and government technicians were active "member" participants in its organization and activities. One by one a total of ten departments and agencies had joined the Association as member bodies. Government officials had been members on the Board of Directors, the Standards Council, key administrative committees, and the technical committees.

To avoid the complications of financially obligating the government, government member-body status was granted without payment of dues or other monetary assessment. All other privileges of participation, including the right to vote, were granted. With the incorporation of ASA in the

State of New York, the legal hiatus which it generated caused withdrawal of government from direct member-body participation. The co-equality of the industry-government relationship in the development of voluntary standards was thus destroyed.

No attempt is made here to deal with this legal question; it is useful, however, to point up some of the difficulties it causes in the progress of the government's standards program.

The broad significance of the latter was cited by Senator Ralph E. Flanders in his remarks to the Senate in sponsoring a bill to incorporate the ASA under a federal charter.[15] He said: "The Federal Government is interested in industrial standardization in two ways: First, as a purchaser, it is interested in an extraordinarily wide range of specifications for materials and apparatus; and second, through its great service and research bureaus, whose function is to serve industry and commerce . . ."

Again in support of an active government relationship, which the proposed charter was designed to bring about, Senator Flanders stated that "the total war effort absorbed nearly one-half of the national economy. The need for Industry and Government to use and work to the same standards was unprecedented. Wherever industry was not accustomed to working to standards at least similar to those laid down by the Government, the resulting disruptions and misfires were extremely costly."

Early in the effort to broaden GSA's standardization program, it became increasingly evident that success depended largely upon close cooperation with technical societies, trade associations, and suppliers. Not only must the government provide greater facility for its technicians to participate in standards projects of the societies and associations, where government interest warrants, but it must also be represented at general technical meetings of such groups to exchange views on matters of mutual concern.

Provision is also necessary to give industry groups and suppliers the opportunity to participate on a regularized basis in the development of government standards. With this in mind, the Administrator negotiated with the Department of Justice policies and procedures under which required industry technical advisory committees and industry advisory technical conferences can be organized.

The technical committee is designed to provide machinery for continuing technical advice covering specific categories of standards. The technical conferences offer a ready means for calling together a representative industry group for advice on a specific technical standards problem. The policy clearly recognizes the part to be played by technical societies and trade associations in advising the government on its standards problems and, most important, makes it possible for trade associations to be represented on such groups. The Department of Justice concurred in the policy.

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[15] *Congressional Record,* 81st Cong., 1st sess., Vol. 95, Part 11 (October 6, 1949), p. 13979.

The General Services Administration is studying the formulation of the policy and procedure which will permit its technicians to participate on a similar basis in the technical committee activities of groups such as the American Standards Association and the American Society for Testing Materials. This consideration involves establishing the basis upon which such technicians reflect their views on proposed standards in the letter-ballot-voting procedure invariably used in formulation of standards and specifications.

It is hoped that with these steps the two-way street formerly in effect can be re-established to the end that government can make more extensive use of existing standards; that needed industry end-product standards which can be used by the government will be developed, and that government standards of general concern to industry will be adopted as national standards.

Impact of Federal Standards on Federal Agencies

Federal Standards and Federal Specifications are mandatory for use by all federal agencies. The use by federal agencies of Interim Federal Specifications and Interim Federal Standards is voluntary. In other words, the interim issue is designed to provide an immediate procurement document. This is done by shortcutting the longer coordinating process with suppliers and agencies necessary under the federal specification procedure; and it affords a period of use to test and improve the interim issue before issuing it as a Federal Standard.

To be practical, provision is made for agencies to take exception to the mandatory standards as follows: (1) in instances of public exigency, (2) for small lot purchases not exceeding $1000, (3) for supply items involved in new processes, installations, or equipment, (4) for items used for experimental purposes, test, or research and development, (5) for purchases involving spare parts, components, or materials required for repair or maintenance of existing facilities, and (6) for items purchased in foreign markets for use of overseas agencies.

On occasion it is necessary to issue an Interim Federal Specification or an Interim Federal Standard for an immediate procurement which involves materials or equipment specified in an existing Federal Specification or Standard. In such cases the interim issuance is considered a valid exception to the existing Federal Specification or Standard. Otherwise serious conflicts in specifications would occur.

Repetitive exceptions taken by agencies are required to be reported to provide the necessary review as to the efficacy of allowable exceptions and for keeping the specifications up to date.

The increasing availability of uniform Federal Specifications and the introduction of Federal Standards has spotlighted the importance attached to their effect upon government supply. The individual departmental specifications with their varying requirements, test methods, and inspection procedures have in the past caused numerous variations in the items supplied to the government.

During war time and periods of high federal consumption for national defense, these differing standards introduced by the agencies have made it difficult to meet supply requirements. Agencies were competing with one another for the available supply. This not only prevented an orderly supply pipe line but resulted in serious disruption, at both the supplier and government level. Costs of deliveries have varied, costs of transportation have become excessive, and, more important, sources of supply have not always been effectively utilized.

Procurement of furniture under varying specifications is a good example of what happens when several agencies compete for supply. At one time the Federal Specifications for furniture named hardwoods largely available from the eastern seaboard. Consequently, west coast furniture manufacturers could not participate, and west coast requirements were met by shipping furniture cross-country. By broadening the acceptable types of wood geographically, by unifying the specifications for the various pieces of furniture, it has been possible to let competitive contracts at prices including shipping costs which reflect the geographic advantage when it is a factor of supply.

The policy regarding packaging, which was discussed above, contributes to increasing uniformity of civil and military packaging requirements. In instances where civil supply applications require the highest level of packaging, advantage can be taken of the packaging work of the military.

Federal Standards for basic packaging requirements can now be developed for application to any number of types of products covered by individual purchase specifications. This broader application of the Federal Standard to government-wide supply, both civil and military, will, as it goes forward, have extensive impact upon the supply activities of federal agencies. It will aid in formulating uniform policy and method, and extending the sources of supply so as to give both large and small companies a share of government business.

To accomplish the objective of adequate coverage of standards to service the needs of supply activities in the common items area will require preparation of about 3000 additional Federal Specifications. Experience shows that about 50 per cent of the work effort is required in revisions of specifications.

The objective is to gear the work so that in about five years 1200 new and revised specifications projects will be initiated annually. In this period and at the rate of 600 new specifications a year, the 3000 additional new specifications will have been provided. Assuming that the rate of 1200 work units can be maintained thereafter, it will be possible to review and revise as necessary, or reaffirm, each specification once in five years thereby maintaining the system up to date. It must be understood that at any time any given specification is found out of date, causes trouble in procurement, or does not reflect new developments in production or industry practices, it must and will be revised.

This is an ambitious program for which budget is not now available but which is essential if the federal government is to provide the required uniform specifications for common items of supply. For example, at the present time 55 per cent of General Services Administration's General Supply Fund and Federal Supply Schedule purchases are covered by specifications. It is estimated that an additional 45 per cent, or a total of 6000 specifications, are required to service the supply system of the federal government adequately. The Interim Federal Specification program will play a large and important part in attaining this objective at reasonable cost.

It is equally essential that the federal government standardize important lines of commodities. As pointed out above nearly seventy standardization projects have been completed; only twenty-two are scheduled in each of fiscal years 1956 and 1957. In subsequent years, this pace must be accelerated if we are to standardize the important categories of common items within the Federal Supply System.

It is through this kind of a program that the government will realize the continuing savings from the standards effort. Their full potential cannot be achieved unless the system of specifications and standards is applied across the board to all important and large money volume items in the system.

A piecemeal approach and catch-as-catch-can attempts to maintain the work current with technological development are not enough. While ambitious, this full-scale program can and should be undertaken. The disruptions to industry by the impact of large volume government demands will thus be minimized, and an increasing contribution to the economy, which better nationally recognized standards make, will be realized.

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22. STANDARDS IN THE FEDERAL SUPPLY SYSTEM— MILITARY GOODS

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INTRODUCTION

THE DEPARTMENT of Defense Standardization Program is conducted under the statutory provisions of Public Law 436, 82nd Congress.[1] This Standardization Program is concerned with: (1) standardization of materials, components, equipments, and processes with respect to items and services approved for use by the Army, the Navy, and the Air Force; and (2) standardization of engineering practices and procedures essential to design, procurement, production, inspection, application, preservation and preparation for delivery of items of military supply. This essay describes what is meant by standardization, as practiced in the Department of Defense today—what it is, what it does, and how it is administered.

WHAT STANDARDIZATION IS AND WHAT IT DOES

DEFINITION AND PURPOSES

The term standardization as used in the Department of Defense means a process by which limitations are imposed by common agreement on engineering criteria, terms, principles, practices, materials, items, processes, equipment, parts, assemblies, and subassemblies. Its major purposes are: (1) to improve the efficiency and effectiveness of logistical support, and operational readiness of the Army, the Navy, and the Air Force; and (2) to conserve money, manpower, time, production facilities, and natural resources.

To realize these over-all purposes the following specific objectives have been established:

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[1] "Defense Cataloging and Standardization Act." 66 Stat. 318, 5 U.S.C., sec. 173, 173a (1952).

1. Adoption of the minimum number of sizes, kinds, or types of items and services essential to military operations.
2. Achievement of the optimum degree of interchangeability of the component parts used in these items.
3. Development of standard terminology, codes, and drawing practices to achieve common understanding and clear interpretation of the description of items and practices.
4. Preparation of engineering and purchase documents to insure the design, purchase, and delivery of items consistent with the scope and purpose of the Defense Standardization Program.
5. Providing the military departments with the most reliable equipment possible by the adoption of material which has been evaluated in accordance with established government specifications and standards.

WHY STANDARDIZATION IS NECESSARY

An estimated 2.6 million "line" items[2] are stocked in the military supply systems. This indicates the possibility of an excessive variety to meet logistics requirements.

Over a long period of years, the individual elements of the military departments had the responsibility of determining their own requirements, and of developing their individual specifications for purchasing the items necessary for their individual missions. This means that each bureau of the Navy and each technical service of the Army has been for decades developing specifications for materials and products considered best suited for its own military needs. In addition, during periods of emergencies, such as World War II and the Korean incident, it was generally necessary to procure from industry, by using performance specifications as the criterion for acceptance, whatever could be produced to meet military requirements. As a result, the spare parts and line items required for supply and maintenance have multiplied to an enormous inventory, causing overlapping and duplication in such supplies among the three military departments. Within industry, a variety of such simple things as fastening devices—e.g., rivets, bolts, and nuts—total over 400,000 individual items. It is possible that, if no limitation were imposed, the military departments could include in their supply systems a stock of each one of these 400,000 individual nuts, bolt, and rivets based on their unlimited application to military equipment.

In times of stress, when the economy is making every effort to supply defense needs, the variety of supplies used results in a variety of products, similar but slightly different. In turn, this requires a large variety of supporting parts for the maintenance of those products. It has been estimated that the number of new items which enter the supply system each year may be as high as 250,000. The addition of new items has three main causes: the development of new equipment, advances in the arts, and technological development. It becomes a matter of major importance, therefore, that when something new is adopted, something obsolete should be considered for rejection.

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[2] A line item is an item of inventory, stocks of which are carried in depots and other military supply points. The inventory level of goods carried in the military supply systems may include many individual units of a single line item.

Major items of military equipment have a life expectancy of many years. Even though it is possible to limit the variety of nuts and bolts, rivets, antifriction bearings, resistors, capacitors, electrical connectors, and other common-use items in the design of new equipments, those items needed to sustain still useful weapons must be carried in supply for many years.

The greatest benefits from standardization will be achieved not in the less complex areas, such as food and clothing—the simple things by which we live—but rather in the engineering elements of those things from which other things are built; that is, the component parts and so-called "bits and pieces." In the past, many extremely effective standardization actions have been taken, not only by the individual military departments but also jointly by two or more departments. Many standards have been developed over the years by the technical services of the Army, by the technical bureaus of the Navy, and jointly by the Air Force and the Bureau of Aeronautics. Each one of these standards, developed independently, has achieved a degree of limitation within that individual organization. The military departments have also made use of commercially accepted standards of such societies as the American Society for Testing Materials, the American Institute of Electrical Engineers, the American Standards Association, the American Iron and Steel Institute, the Society of Automotive Engineers, the American Society of Mechanical Engineers, and many others. There has been no dearth of standardization activity throughout the country but, rather, an inadequate effort to bring various parts into focus and to take advantage of the results produced by many over a long period of time.

An over-all Department of Defense Standardization Program is therefore necessary to limit the variety of equipment and supplies in the military supply systems. Such a program has been designed to establish limitations on supply items and related engineering practices. It is intended to correct the situation that has grown out of the conditions just described; i.e., the differing missions of the military departments; their freedom in the past to procure the items of support; the emergency conditions which made it imperative to procure from various sources supplies without regard to their identity; the need for maintaining obsolescent but still usable military equipment; the development of new and highly complex weapons requiring additional thousands of supply support items; and the rapid pace of technological advance.

HOW STANDARDIZATION ACHIEVES ITS PURPOSES

Standardization aids in the objective of improving logistics support in the following ways:

1. It reduces variety to a minimum. The fewer items required to be managed in the supply system, the simpler will be the managerial job.
2. It places a limitation on design selection. This is where interchangeability of parts becomes a major factor in increasing logistics efficiency. Limitation on design selection also results in simplified cross-servicing among the military departments and facilitates maintenance of equipment by "cannibalization"—tearing down of one piece of equipment to maintain other like equipment in operation.
3. It establishes firm levels of quality and performance for the items needed for defense. Standardization limits variation and creates a common understanding between supplier and user. At the same time it insures fair competition among the manufacturers who sell to the government.
4. It provides a broader production base by encouraging more suppliers, both large and small, to manufacture a larger volume of products of a smaller variety.
5. It simplifies demands on industry by eliminating special requirements, including variation in testing requirements, inspection procedures, and packaging methods.
6. It establishes for the three military departments uniform technical practices, such as welding procedures, surface preparation, and drawing practices. Uniformity in these fields results in greater operating efficiency, higher production, and a broader degree of understanding on the part of industry of what military requirements are. Further, standardization assures that industrial production lines need not be changed when filling contracts for the Army today and the Navy tomorrow.
7. It offers a major tool for improved logistics management by promoting a common understanding of the engineering and supply aspects of the logistics problem by all elements of the logistics system. This system begins with the original determination of what is required with respect to weapons for the defense of the United States. It is essential, therefore, that those individuals concerned with design, development, procurement, supply management, and with all other logistics functions know which standard items are to be utilized, which standard items are available, and which items should be removed from the supply system.

Standardization develops a common language of supply and a common technical language expressed not only by the written word but also by authorized symbols and detailed engineering drawings.

Standardization Processes

In the Department of Defense standardization is accomplished through two major processes, namely, "item standardization" and "engineering standardization."

ITEM STANDARDIZATION

Item standardization calls for two kinds of review which have been termed "simplification" and "technical analysis." The objective of "simplification" is to eliminate the nonessential variety of types, kinds, and sizes of individual items, including obsolete, duplicate, and overlapping items of supply. Simplification starts with an examination of all items within the supply system and the identification of those considered necessary to be carried in stock in the future as well as those which can be eliminated. This process results in the rejection of obsolete items, the elimination of separate stocking by the individual military departments of items which are so similar that they are considered interchangeable with others.

In carrying out the simplification process, the information developed by the Federal Cataloging Program is the means used for identifying all items carried in the supply systems. Simplification challenges the need for the variety of items. It is then incumbent upon each of the military departments, their operating elements, and their supply managers to justify the need for such variety, or to agree on those items to be eliminated from stock.

"Technical analysis" has as its objective the determination of items necessary for future design, procurement, and repetitive use. By means of technical analysis and redesign, the variations authorized for new design will be reduced to the minimum found to be practicable. In this process the advantages of reduction of variety are examined in the light of established requirements, the problems of production, and the possibility of establishing an adequate production base for emergency periods. The relative merits of three levels of standardization—unit interchangeability, component interchangeability, and complete parts interchangeability—are compared. Standard items may result from the "simplification" phase or the standard items decided upon may be entirely new and designed to fill needs formerly requiring several varieties. Since technical analysis is an evaluation of function, a minor design change of one item may suffice to replace several existing items, or a new item, completely redesigned, may replace many others. This is a prime characteristic of standardization—namely, the attainment of the maximum degree of interchangeability. Thus, in the military standardization of industrial internal combustion engine parts, each new standard part has been designed to fulfill engineering requirements which previously required up to fifty varieties.

In both of these reviews (simplification and technical analysis) the items rejected for future design and procurement are made known to the supply managers who take the necessary steps either to utilize existing stocks until exhausted or otherwise to dispose of them.

ENGINEERING STANDARDIZATION

Engineering standardization is the second major process for accomplishing standardization. It imposes a limitation on interpretation and understanding of such things as drafting practices, symbols, abbreviations and codes, as well as the basic characteristics of equipments, items, and materials.

Standardization of military items begins at the drawing board. In order to tell industry clearly what it is the military requires, drawings are necessary. In many cases government drawings are furnished. In other cases, when industry designs items under military contract, it must supply the drawings for approval and finally for use in procurement and for maintenance. It becomes essential, then, that common practices with respect to the interpretation of drawings exist not only among the various elements of the military departments but also between a military department and industry. Here again, over a long period of years, varying practices have developed. Differing symbols that mean the same thing, or identical symbols having different meanings, including abbreviations and technical terms, have been developed within the various elements of the military departments and within different segments of industry. These variables lead to misunderstandings, wrong interpretations, and delays in reaching agreement. Engineering standardization is the means whereby this confusing condition is remedied, for example, all of the military departments and their contractors now use the same method of showing dimensions. The same applies to welding practices and to the symbols denoting the kind of weld to be used. Standard abbreviations have been developed which include mechanical, electrical, and related engineering terminology. In addition, drawing sizes, which were previously unlimited in variation have been standardized.

STANDARDIZATION AS A TOOL

Once a reduction in multiplicity of items carried in the military supply system is achieved, there follows the need for maintaining the gains that have been won. This is accomplished through the issuance and use of two supply-management documents—standards and specifications. New items keep entering the military supply system as a result of the development of new weapons, work on research projects, and industrial progress. These new items are also screened to determine need for them and their conformance to existing standard items.

LIMITING VARIATIONS IN THE SUPPLY SYSTEM

Basically, the way of keeping the supply system uncluttered is through the issuance of mandatory standards for use throughout all elements of military design, procurement, and supply. Primarily, a standard is a limitation on selection.

Standards, as documents which limit selection, prevent unnecessary items from entering the supply system. They establish and limit engineering practices and processes used in the preparation, manufacture, and testing of materials, designs, and items. They establish uniform methods for acceptance inspection, including testing procedures and instrumentation when necessary. They establish and limit the materials and methods which may be used in preserving, packaging, packing, and marking of items for identification, transportation, storage, and issue. In addition, by defining in detail the engineering characteristics of parts, standards provide for physical and functional interchangeability and compatibility of items and equipment, insure essential quality or reliability of items, and specify the necessary health and safety features required.

PREVENTING ENTRY OF NONESSENTIAL ITEMS INTO THE SUPPLY SYSTEM

The individual in the logistics cycle who is first concerned with the use of standards for the selection of items is the designer. After standardization is sufficiently advanced, the designer, whether a member of a military department or in the plant of a contractor, must limit his designs to the use of standard parts and practices to the maximum extent feasible. The procurement officer is also limited in the purchase of those items authorized by the applicable standard. The supply manager, charged with inventory control refers to standards as his guide in determining which items will be procured for replenishment and which nonstandard items require disposition action.

KINDS OF STANDARDS

The Department of Defense uses the following kinds of standards:

First, there are those identified as *federal* standards. These are issued by the General Services Administration and cover items and practices common to both the military and civil agencies of the Federal Government.

Second, there are *military* standards issued by the Department of Defense which limit the selection of items or practices for use by the military departments.

Third, there are *industrial* standards developed and issued or approved by nationally recognized organizations. These standards are utilized both in the development of military standards and by direct reference. There is a notable difference between nationally recognized industrial standards and federal or military standards, in that the former are optional for use by manufacturers, while government standards are mandatory in the manufacture of military equipment. The adoption of an industrial standard by the Department of Defense, however, makes that standard mandatory for use within the military departments in the same manner as a military standard. To the extent that industry standards can meet military demands, it is the policy of the Department of Defense to adopt them without modification for use in the design and procurement of military equipment.

Fourth, there is a system of *international* standards. These are agreements based primarily on military or federal standards which have been adopted for joint use by the American-British-Canadian Governments or by the NATO countries.

SPECIFICATIONS AS PROCUREMENT DOCUMENTS

Specifications are documents intended primarily for use in procurement. They are clear, accurate descriptions of the technical requirements for items, materials, or services, including the procedures by which it will be determined that the requirements have been met. Specifications may be of two types—performance or design.

A performance specification describes the characteristics of the item being purchased and stipulates the performance requirements to be met by the product. Under a performance specification, the manufacturer designs the item, determines the materials required, and supplies a product that will meet the acceptance criteria.

A design specification gives a complete description of the end product and the materials of which it is to be constructed. It may also specify the manufacturing processes to be used.

Two essential stipulations are required in both performance and design specifications. One is a statement of the tests that will be used to determine whether the item complies with the description. The other is a statement of the requirements for packaging, packing, and marking. These two requirements, incidentally, are frequently omitted from industrial specifications in contrast to those prepared by the government.

KINDS OF SPECIFICATIONS

The kinds of specifications used within the Department of Defense are:

Federal specifications which are issued by the General Services Administration and are used for the purchase of items common to both military and civil agencies of the Federal Government.

Military specifications which are issued by the Department of Defense and which are used for the procurement of military items. Military specifications are of two kinds: coordinated and limited coordination specifications. A military department that wants to prepare a specification for repetitive procurement of any item is now required to determine the degree of interest in that or similar items existing in the supply systems of the other military departments. If such an interest exists, the specification must then be prepared as a *coordinated military specification,* citing the common requirement of all interested military departments. If no interest exists within the other military departments, the specification may then be issued as a *limited coordination military specification* by the department concerned. Should future interest develop in either of the other departments for the same or a similar item, full coordination is then undertaken, the product of which is a coordinated military specification.

EXCEPTIONS TO THE USE OF SPECIFICATIONS

It is a basic policy of the Department of Defense that specifications in the military or federal series shall be used for the procurement of all items repetitively bought, stored, and issued by the military departments, except for the following:

1. Items required for research and development.
2. Items required for test or evaluation.
3. Items required for specialized laboratory equipment.
4. Items required for authorized resale, except military clothing.
5. Procurements in amounts not to exceed $1000 (this exception is not permitted to be used as a method of avoidance).
6. Items required on a one-time procurement basis only.
7. Items for which it is impracticable or uneconomical to prepare specifications.

New Department of Defense Program

ORGANIZATIONAL HISTORY

Impetus was given to military standardization between and among the military departments by the establishment in 1942 of the Joint Army-Navy Committee on Specifications. In 1945 this Committee was succeeded by the Army-Navy Joint Specifications Board, the purpose of which was to produce a joint Army-Navy series of specifications for items and materials similar in their technical requirements.

In 1948 the Munitions Board, authorized by the National Security Act of 1947 as a staff element of the Office of the Secretary of Defense, established a Standards Agency under its jurisdiction. From 1948 to 1952 the Munitions Board's Standards Agency underwent several reorganizations. When Public Law 436 established the Defense Supply Management Agency in 1952, the Munition Board's Standards Agency became the Office of Standardization under the Defense Supply Management Agency. Still later, in 1953, the President's Reorganization Plan No. 6 abolished the Munitions Board and created in its place the Office of the Assistant Secretary of Defense, Supply and Logistics. Thus, the former Defense Supply

Management Agency Office of Standardization became the Standardization Division under the Director of Cataloging, Standardization, and Inspection of the new Assistant Secretary of Defense (Supply and Logistics).

RESTATEMENT OF BASIC PRINCIPLES AND POLICIES

Each change in the organizational history of the Standardization Division (Office of the Assistant Secretary of Defense, Supply and Logistics) brought a corresponding change in its character, its responsibilities, and its authority. Soon after the newly created organization was established, it was decided to reappraise carefully past efforts in this field and to set the course for future standardization efforts to satisfy fully the requirements of Public Law 436.

After an inventory of standardization efforts and accomplishments up to that point, it was determined that a statement of Department of Defense standardization principles and policies, uniformly applicable to the three military departments, would have to be made. Such action was taken in October 1954 by the issuance of Department of Defense Directive 4120.3, titled "Defense Standardization Program."[3] This directive sets the tone and the task for the whole standardization effort by:

—stating the major purposes and objectives of standardization;

—defining the scope of the standardization program;

—outlining a workable plan for accomplishing standardization in the military departments;

—establishing basic policies and principles for carrying out the plan;

—assigning specific responsibilities to the management levels of the Office of the Assistant Secretary of Defense (Supply and Logistics) and the military departments;

—providing for the necessary organization in each military department to carry out its responsibilities under the program;

—requiring a uniform reporting system for appraising results.

The Department of Defense Directive has become the authority for utilizing all resources of the Department of Defense in accomplishing standardization, as called for in Public Law 436. Further, it assigns to the military departments subordinate responsibility for the operating portions of the program in a manner consistent with departmental capacity and supply interest, and with due regard to departmental mission.

Assignment of standardization responsibility to the military departments is to be made for: (1) supply items, by classes in the Federal Supply Classification System, as developed by the Cataloging Program; and (2) general engineering standards, by processes, practices, codes, standard terminology, etc., required for logistic support.

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[3] Reprinted as Appendix A of the *Military Manual for Standardization,* M201, August 1, 1953.

BASIC POLICIES STEMMING FROM DOD DIRECTIVE 4120.3

A concise restatement of the basic DOD standardization policies follows:

1. There will be but one Department of Defense Standardization Program.
2. It will be an accelerated program.
3. The Office of the Secretary of Defense will manage and control the program by planning, directing, and reviewing its operations, which, in turn, will be decentralized to the military departments with authority further to subassign portions of the operations, as necessary.
4. Interdepartmental coordination on all standardization matters having an impact on more than one department will be required.
5. Assignments and subassignments of standardization to the military departments will be made on the basis of departmental capacity and supply interest.
6. The coordinated specifications and standards derived from standardization effort will be mandatory for use throughout the military supply systems and in the design of new products where practicable. Any deviations or waivers from specifications or standards will be approved by competent authority and justified in writing.
7. Standardization efforts will not be limited to domestic standardization only.
8. Industrial coordination will be required in the development of specifications and standards.
9. Industrial standards will be adopted where practicable for military use.

DETAILED GUIDANCE AND PROCEDURES

After the basic principles and policies required to achieve standardization objectives were redefined, the next major task was to develop detailed policy guidance and procedures on how the departments are to do the job. As a first step in developing detailed procedures for this program to aid the military departments in carrying out their portions of the program, a *Military Manual for Standardization,* M201, was developed and issued. It furnished the necessary guidance and prescribed a sequence of actions required of the military departments in discharging their responsibilities under the new program.

Briefly, the detailed procedures involve the preparation by each military department of a series of preliminary proposals for scheduling the workload for each Federal Supply Class assigned to it. These preliminary proposals will give the names of the organizational elements within each military department designated to coordinate the work of the participating departments as well as the date of submission to the Standardization Division—OASD (S&L)—of detailed plans of action to accomplish standardization. The technical service, bureau, or command in the departments designated to carry out the standardization assignment will collect, from whatever sources are available, the data needed to determine the standardization potential of a total FSC class. Once the determination is made, the department will prepare and submit to OASD (S&L) for approval a detailed plan of action to accomplish this potential.

The detailed plan of action, when approved, will prescribe the method of procedure (including means of coordination within the military departments), stipulate the subassignments for the work involved, specify time schedules for completion, identify those items most suitable for standardization, and establish priorities for undertaking studies in such areas.

As part of the task of giving specific guidance to the military departments, a series of detailed procedural manuals will be published on the preparation and use of the different standardization documents—Standards, Specifications, Qualified Products Lists.

TIME CYCLE FOR ACCOMPLISHING NEW PROGRAM

Because of the magnitude of the overall standardization effort, which involves nearly 2.6 million items, it would be impossible to devote the necessary manpower to undertake standardization of all these items at the same time. Therefore, it is necessary to phase the total program over a period of years. A minimum of five years was the estimated time required to accomplish the first cycle of the new Defense Standardization Program, i.e., it was planned that by the end of fiscal year 1960 all preliminary proposals and all detailed plans of action will have been developed and approved for all Federal Supply Classes. More than 500 Federal Supply Classes, which categorize all commodities of military supply into families of related items, have been assigned to the military departments. This total task will require progress at the rate of about 100 Federal Supply Classes each year.

The first year's approved standardization program (fiscal year 1956) calls for the submission by the departments during that period of a number of preliminary proposals and detailed plans of action. It is expected that the accomplishment of standardization actions resulting from the detailed plans will be accelerated in succeeding years, until finally all items in the military supply system will have undergone the standardization screening process.

At the same time that the new and logically programmed standardization effort in being launched, the military departments will continue their efforts under their older program. In this connection, about 2000 standardization projects had been assigned to various elements of the military departments as of the beginning of fiscal year 1956. These projects include the development of specifications, revisions and amendments to them, standardization studies of various groups of items, and the development of specific item standards, as well as engineering standards. Such projects cover the complete range of Federal Supply Classes but were developed independently by items, rather than within the framework of a well-defined and integrated Defense Standardization Program.

TRANSITION TO THE NEW PROGRAM

To accomplish a smooth transition from the old to the new procedures, work is to be accelerated on those projects established under the old procedures, while simultaneously detailed standardization plans on specific Federal Supply Classes are to be developed and implemented. Approximately half of these older projects have been scheduled for completion during fiscal year 1956.

MAJOR TASKS YET TO BE DONE

A revitalized Defense Standardization Program has been formulated, the detailed policies and procedures for carrying it out have been issued, and a time schedule for its accomplishment has been set. Several tasks still remain, however, before the program can gather its full momentum and meet all the requirements of Public Law 436. One of these is the establishment and staffing of an organization adequate to manage and operate so vast an enterprise throughout the military. The Department of Defense Directive of October 1954 requires each military department to set up a responsible organizational unit to manage the standardization effort, and specifies the responsibilities assigned to it as follows: (1) coordinate standardization efforts of the services, bureaus, and commands; (2) establish adequate budgets and staffs for standardization operations and the integration of departmental and Department of Defense standardization. Another task is the provision of adequate fiscal support to sustain the planned work program throughout its scheduled span of time.

Still another major task is the development of an adequate reporting system that will provide necessary and timely information to the various echelons of management in order to highlight the relationships of progress to planned results, costs to benefits, and cause to effect.

Some measures have already been taken in these areas but there remains more to be done.

The Deparment of Defense believes that the basic principles and policies upon which its standardization program has been built will produce in the years to come, under effective management, a far greater return to the nation than the cost of the undertaking, not only in the number of tax dollars saved but, even more important, in the major improvements within the logistics system of the military services and in the operational readiness of the Army, the Navy, and the Air Force.

23. TEXTILE STANDARDS AS VIEWED BY THE STORE TECHNOLOGIST

JULES LABARTHE

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THE INDUSTRIAL consumer or user of goods has his collection of specifications which must be met by his purchases of raw materials, supplies, and finished goods. He does not always insist upon the very highest degree of performance in these things he buys; rather he has a sliding scale of standards of quality, depending upon the severity of use to which they will be exposed in his plant or by the finished product he manufactures. The more severe the use, the higher is his required standard of performance; but he also has a floor of performance, and goods falling below it will not be acceptable, for he knows full well that products which do not meet these minimum standards will be an endless source of annoyance and waste to him.

A chemist or an engineer employed in a retail store laboratory or in a commercial testing laboratory in the evaluation of consumer goods finds himself in much the same position as his brother scientist serving an industrial company. The essential difference is that in serving the retailer he is a full step closer to knowing the wants and needs of the consumer and is exposed directly to the problem of weighing factors influencing sales appeal versus those dealing with serviceability. He serves the retail establishment well if his philosophy of testing goods for their end-use serviceability and his development of testing procedures to forecast consumer experience, and the sales information developed thereby, are useful to the store's customer. For this customer—the average consumer—details of standards are unknown and for her the levels of performance quality have been ill-defined in most kinds of commodities.

Private Laboratory Standards for Textiles

Through years of experience, the laboratory will have acquired a considerable backlog of information, and generally has prepared minimum standards of performance for textile and some other products; goods falling short of these standards will not be recommended for purchase by the store for resale to its customers. Most such laboratories have had their own private files of performance data. Duplicate testing and evaluation of a new textile fabric, a new dyestuff, or an unusual finish have been wasteful and time-consuming because each individual laboratory has been called upon by the store it served to make its own evaluation of the product as to its suitability for sale to the public. Those of us who have devoted many years to this kind of scientific endeavor have been conscious of the waste, and yet there seemed to be little that could be done about it because of a lack of widely recognized and agreed-upon standards.

The store's buyer or the merchant is primarily concerned with customer wants—the appeal of textile products. Included in this category are price, style, color, and texture, the elements that first attract the eye of the shopper. The technologist is concerned with consumer needs; that is to say, the properties or qualities of the textile product that will enable it to give good wear and service, including satisfactory cleanability either by washing or by dry cleaning. It may not be an oversimplification to state that a satisfactory textile purchase by a housewife depends upon the degree to which it has satisfied both her customer wants and her consumer needs.

Thus we see that, in the comparison of two or more lines of goods or in the appraisal of a single product offered to store buyers for resale to the public, the one question that laboratory technicians are called upon to answer is: "How will it serve the purchaser?" This question is elemental to our work, and for that reason all store laboratories and those advising the ultimate consumer must have the consumer's point of view and interest first in mind. If we satisfy the consumer, the store customer, we will in the long run best satisfy our actual employers—the stores. It is a matter of direct proportion.

National Standards for Textiles

Textiles, the so-called soft goods lines, constitute approximately 80 per cent of the total sales of any department store, and are therefore the main subjects of our investigational procedures. We could have gone along as we did for some years, each laboratory being on its own, but what of the textile producer making the goods for sale everywhere in the United States and abroad? What of the garment manufacturer who is called upon to satisfy customers the nation over, and who would be desperate if required to meet the individual demands set up by each store having at its service some kind of laboratory facilities? A manufacturer's line might be acceptable to one store at a certain price; it might be unacceptable to another store at that price or any other. Some of the less ethical manufacturers have for years been playing one store laboratory against another, endeavoring to get products into both retail establishments. Despite the fact that the technologists in the laboratories of retail establishments and in commercial testing laboratories have been actively engaged in textile testing and evaluation and the establishment of private brand standards or specifications since the mid-twenties, there has been an almost complete dearth of nationally recognized standards for textiles for the consumer.

STANDARDS DEVELOPED BY TECHNICAL SOCIETIES AND THE GOVERNMENT

The textile technical societies have had tremendous growth during the past thirty years, but organizations like the American Association of Textile Chemists and Colorists and Committee D13 (the committee on textiles) of the American Society for Testing Materials have confined themselves to the development of test methods and the standardization of procedures among laboratories. Commercial Standards issued by the Department of Commerce deal essentially with standards applicable to textile products purchased by the government or industrial users; many of these standards satisfy some but not all of the particular use-requirements of the American household. Federal legislation dealing with textile products (the Wool Labeling Act, for example) does not concern itself with fabric performance in use, but is designed to prevent misrepresentation of the kind of raw material used in goods offered the customer. Similarly, Federal Trade Commision's fair trade practice rules do not provide specifications for fabrics. The store technologist favors the development of definitions and performance levels by voluntary cooperation on the part of all elements of the industry rather than having mandatory rules laid down by governmental agencies or departments, except when public safety is affected, as in the case of the Flammable Fabrics Act of June 1953, or when trade practices are deceptive and misleading to the public.

STANDARDS DEVELOPED BY THE ASA

The American Standards Association, acting under the sponsorship of one or more of its member groups, has undertaken the development of voluntary standards for several textile products for consumer use. Among the ASA standards were American War Standards for protective clothing for men and women in industry. In November 1948 there was issued an American Standard for four types of sheets and sheeting useful to both the large-scale and individual purchasers of bedding. The standard for rayon and acetate (ASA Sectional Committee L22, Rayon and Acetate Fabrics) was issued in 1953 after nearly four years' work. It consists of thirty-one test methods applicable to textiles for various end-use requirements, not all tests, of course, being required for every end-use. The standard covers fifty-one different end-use items of wearing apparel for men, women, children, and infants, and household fabrics composed of rayon or acetate fibers in excess of 50 per cent by weight. This is the first standard which deals with the completed article as the customer buys it in the store: it covers not only the basic fabric of which the article is made but also the washability, cleanability, shrinkage, and colorfastness of other textile products used in it, such as trimming, thread, braid, etc. Paralleling Sectional Committee L22 are Committees L24 under the sponsorship of the American Hotel Association, dealing with textile products purchased by institutional buyers, and L25, which like L22 is under the sponsorship of the National Retail Dry Goods Association working on textile products of all kinds of fibers. Committee L23 is also a textile standards committee but it deals exclusively with test methods and represents the American Textile industry in the International Organization for Standardization.

Test Methods

The tools for consumer goods standards are the basic test methods and the interpretation of results in terms of anticipated consumer-use experience. For the test method, we have depended upon the nationally recognized procedures of the American Society for Testing Materials, the American Association of Textile Chemists and Colorists, the Commercial Standards of the Department of Commerce, and the Federal Specifications guide. But the test methods and interpretations are not enough. To have only these is like having all the paraphernalia required for a new game together with the specifications for the playing field but with no directions as to how the game must be played. The directions for playing the game of setting up consumer goods standards for textiles lie in utilizing available experience to construct minimum standards against which goods can be measured, so as to have confidence that, when a specific end-use product performs well according to certain standard laboratory testing procedures, there will be little chance of consumer rejection of the product because of poor serviceability. Only laboratories experienced in this kind of merchandise appraisal are in a position to say that a certain breaking strength, a known degree of colorfastness to the various color-destroying agencies, a minimum of shrinkage on washing, or other standards, are required to give assurance that consumers are unlikely to return the article because of poor performance in use. For some of the important consumer-use requirements there were no recognized standard test methods; such methods had been originally developed for institutional use, or with commercial or engineering requirements in mind, and the consumer point of view was not thought of. For that reason, some laboratories had private test methods which, when Sectional Committee L22 on rayon and acetate standards was organized, were then thrown into the mill in setting up standards for fifty-one textile product end-use items.

Sheets and Sheeting

It has been an interesting experience for textile technologists, whether they represent producers, distributors, or consumer groups, to observe that progress is more rapid now than it was in the earlier days of the ASA activity in textile and other consumer goods standards. The ASA sheet standard took many years to develop. Time and again an impasse was reached when the consumers seemed to demand excessively high performance requirements and when the producers seemed to wish to have the standard so low that most sheets of whatever type might be expected to pass. Representatives of distributors were equally guilty in slowing down the project with somewhat unrealistic demands with regard to breaking strength, and requests that an excessive number of types of sheets be included. Sometimes there would be long intervals between meetings and then, when the nucleus of the committee would get together again, through the leadership of one or another of the interested groups, new representatives would be sitting in the chairs of those who had been meeting previously. Again it would be necessary for these "beginners" to be indoctrinated into the basic philosophy of textile standards to make them clearly understand that they represented not themselves nor the firm employing them, but the whole trade association, or technical society, or consumer group by which they had been appointed. Eventually a sheet standard was evolved embracing the three most important types of sheets for the use in the home—the sheets with 128, 140, and 180 threads per square inch. Up to the very last consumers wanted to have rigid shrinkage requirements and yet the store technologists were unanimous in their viewpoint that rarely, if ever, had a bed sheet been returned by a consumer because it had shrunk in service and in washing. It was a want factor on the part of the customer but not a need factor from the point of view of the consumer.

Rayon and Acetate Fabrics

The setting up of consumer-use standards for any textile product is a unique challenge to all concerned. At one end of the production process is the textile fiber about which our technologists know a great deal; at the other end is the finished consumer article—let us say a dress—about which very little is known. Between the fiber and the finished dress lies the textile industry. There the fiber is spun into a yarn and woven into a fabric, which in turn is dyed and given a special finish; the fabric is cut into the garment (by a manufacturer who may have selected it without regard for the condition of use envisioned by the processor); the dress is constructed with a variety of other textile products such as thread, binding, innerlining, etc., and finally the dress is presented for sale to the store buyer and eventually to the ultimate consumer. The dress may have gone through almost as many different company hands as steps involved in its production. There may have been levels of performance required by each element in the production chain from the preceding element. On the other hand, there may have been only the requirement that the goods be dyed or finished at so much per yard. The fact of the matter is that at one end we have a fiber or perhaps even a yarn about which a good deal is known; at the other end, the finished dress, a suit, a blouse, or a pajama about which someone *must* know something if we are to forecast the consumer-use experience. This is where the store laboratory technologist comes in.

For years, those versatile fibers rayon and acetate have been economic footballs in the textile game. Their very versatility is their own worst enemy, for they are capable of being produced in a cheap and shoddy fashion as well as in a good and skillful manner, in infinite constructions and colors, and with every conceivable special finish. Regardless of the kind of performance any two fabrics would give, the good and the bad could look alike to the garment manufacturer, to the store buyer, and to the ultimate consumer. The rayon and acetate fabrics were in poor repute in many stores because of the frequent consumer complaints of poor serviceability and of customer rejection.

It was for these reasons that the National Retail Dry Goods Association requested the ASA to set up the project later known as Sectional Committee L22 to develop performance standards for a wide variety of consumer end-use items made of rayon, acetate, and of blends in which one or the other of these fibers was present to the extent of at least 50 per cent. Fortunately one of our large producers of rayon—the American Viscose Corporation—had a vast backlog of information based upon its Crown-Tested rayon program which was discontinued several years ago. These data pooled with the information supplied by store laboratory technologists, home economists, and the extension service, provided the committee with some floors of performance. These minimum standards, if met in all respects, offered assurance that the product would perform reasonably well, or at least that there would be few complaints; a failure to meet the standards was very likely to lead to trouble.

American Standard L22—really standards for fifty-one end-use items —represents a high point in the activities of the ASA. Its development involved a considerable amount of procedural controversy because ASA requires that all interested groups must be given a chance to be heard. The retailers and the consumers were active in this program, but representatives of some of the producing elements allowed their opportunity to be heard to slip away through abstention as voting members of the committee.

It might be useful to ask ourselves just what American Standards L22, L24, and L25 for textile products mean to the store technologist. They mean that he has a certain definition or measurement of performance agreed upon by a consensus of those with similar interests—namely, serving the consumer properly—and that against this definition he can weigh the results of his own knowledge and experience. His own standards can thus be strengthened. Of further importance to the store technologist is the fact that any higher test value that his store specifies can be exploited as a plus value over and above the national standards. This might be a greater breaking strength, or a higher resistance to abrasion, insuring longer wear. It might be that the dye fastness to washing or to sunlight is higher in his own standards than in American Standard L22. He may wish to utilize the higher serviceability required in institutional fabrics by American Standard L24.

By means of these stricter requirements, plus values may be capitalized upon in the promotion of an exclusive or of an own-brand product by any store. Furthermore, the retailer will be able to say to a manufacturer: "These items in your line are rejected because, according to the American Standard L22, the performance is not up to what is required for satisfactory consumer use." Many technologists are using American Standard L22 in that manner, that is, as a basis for rejection of all or part of a manufacturer's line because it has been observed that a manufacturer may submit first only the goods conforming to standards and later on fill out his line with other goods which will not pass the tests. For example, the later items may lack the required colorfastness or strength requirements of the original samples.

EXTENDING THE WORK ON AMERICAN STANDARDS FOR TEXTILES

Today the synthesized fibers, such as nylon, Orlon, Dynel, Acrilan, and others are those most in the news and in store advertisements. They are the new, the glamorous, the exciting. They offer certain use performances that the natural fibers cannot meet, and yet each has certain physical or chemical shortcomings that render it less desirable for some end-use applications than one of the natural fibers, or rayon or acetate. For that reason and because of the complexity of the problem offered by blends of two or more fibers, the National Retail Dry Goods Association has undertaken the sponsorship of Sectional Committee L25 which, under the ASA procedures, will establish standards for a wide variety of end-use items—possibly the same group that is covered by the American Standard L22.

Store laboratories and those of numerous institutional buyers have many points of view in common. Only recently Sectional Committee L24 set up end-use performance criteria for all textile products used by institutions regardless of the fiber of which the goods are made. Among these ultimate consumers are hotels, motor courts, hospitals, universities, railroads, and bus companies.

It is not intended that every article of clothing or every piece of household textile material covered by American Standards L22 and L24, or those to be included in American Standard L25, should conform to these standards. The ASA in its standards program continually stresses the democratic nature of the process so that harm will not be done to any segment of the industry and so that each may be heard. Furthermore, these standards are to be voluntary; thus they will appeal, it is hoped, to those store buyers who wish to offer a small percentage of prestige merchandise that they can confidently guarantee to give good consumer satisfaction, the kind of merchandise that many consumers claim is virtually unavailable in some markets. There must always be ample variety and choice for the customer who wishes to buy on price alone or on price combined with the other customer aspects of merchandise without regard for its serviceability in use.

EXTENDING THE AMERICAN STANDARDS FOR TEXTILES INTO USE

With the sheeting standard in general use, with the rayon and acetate standards being explored in a tentative manner by many laboratories, and with the various subcommittees studying the all-fabrics standards under the ASA program, it is time for an inquiry as to what should be done with these tools available to the consumer. Taking American Standard L22 as an example, it is apparent that the placement of responsibility for its application is important.

Some persons hold to the opinion that the demand for the use of the available standards for textiles should come from the consumer, with the demand pressuring the retailer. The latter in turn would bring pressure to bear by ordering goods conforming to the standards. Only then will the manufacturer of textile end-use products exert pressure upon his supplier of textiles, and the latter upon his converter, finisher, and dyer. This approach will amost inevitably leave the consumer in a state of frustration because of the time element involved.

There are others who believe that the first effort to extend textile standards into use must come from the top management of the retail trade, the sponsors of the original standards project. From their intermediate position between the producer and the consumer they can exert influence in both directions by placing orders with their suppliers on the basis of standards and by a program of education for their sales personnel and for the public. The standards included in the American Standard L22 are ready for any who wish to use them; they seem to offer the best relief from the kind of textile business which is more conscious of price than of quality or performance. Thus the store technologist finds himself in the position of specifying for the store buyer the end-use requirements to be met under such standards when the buyer decides to supplement his regular stock with one or more brands or lines that can be guaranteed as to serviceability. It will be the responsibility of the store laboratory to test the merchandise shipped, and particularly to evaluate these goods if there should be a customer complaint about them within a reasonable time. For the present, the textile technologists must work together with the textile chemists in the development of American Standard L25, which, although it covers all fibers, will be consolidated into American Standard L22. It is a significant fact that the art and science of textile evaluation have advanced during the past few years, and new test methods more closely duplicating consumer usage may be expected soon through the efforts of the American Association of Textile Chemists and Colorists and the American Society for Testing Materials.

It will be the alert garment manufacturer who selects his materials on the basis of their actual test performance and fitness for use in a particular product. It will be the cost-conscious merchant who specifies in his orders that the goods he buys in his private brand line or in his best volume lines conform to the American Standard for that particular article. It will be the wise consumer who adds to her buying habits the reading of labels and evaluating the information they carry to be able to judge the serviceability of the item, as well as to learn how to care for it properly. It will be the responsibility of the store laboratories and of the commercial testing laboratories to help bring to full and effective use the textile standards which are now available and to encourage the development of additional standards.

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24. CONSUMER GOODS STANDARDS—THE RETAILER'S VIEWPOINT

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Retailers' Stake in Standards for Consumer Goods

WHEN nearly twenty years ago Dr. Paul G. Agnew, almost singlehanded, began the fight for establishing consumer goods standards through the American Standards Association, it was a revolutionary idea which, quite frankly, did not have much appeal to many distributors and manufacturers and was not understood by the great multitude of the ultimate consumers. This battle—for it was a battle—required patience, understanding, stubbornness, and absolute conviction of the useful nature of such a program. Only recently have the benefits been tangible as far as the retailer is concerned, and the great benefits lie ahead. It is because of the future good that these standards will mean to our whole economy that much thoughtful study has gone into this presentation of the retailer's viewpoint toward standards.

The ASA has given the retailers of America a new key to future success in a business faced with an increasing cost of operation. It is giving us real tools of measurement by which we can more intelligently supply our customers—the ultimate consumers in our own trading areas—with all the goods best suited to their own living standards and needs, and with a wide variety of honestly valued luxury items to fulfill their additional wants. Some of this program has been achieved; most of it remains for the future.

There are two fundamental, unalterable facts to be considered: first, the great bulk of goods produced in the United States is intended for the use and consumption of the individual consumer unit—the family—or even the individual consumer; second, the store buyer selects those goods which in his estimation will be preferred by his customers—the families patronizing his store. Consumer goods standards supply the means of communication by which the manufacturer can describe the real qualities of his goods to the store buyer. The buyer, as the purchasing agent, can in turn pass on this information in unmistakable terms to the customer.

Why, then, have these standards been so long in their development? I think one reason is that many persons in business, both at the production and at the distribution levels, still misunderstand and fear the word "standard," feeling that it has something to do with regimentation, curtailment of materials of construction, and limitation of style and design imagination. They overlook the fact that in the voluntary standards program of the ASA we are seeking simply a system of measurements by which the ultimate usefulness and serviceability of a consumer goods item can be measured and labeled so that the final purchaser—the ultimate consumer—will know how best to keep it, use it, and care for it.

PURCHASING AID

The retailer needs merchandise standards as a guide to buying, an aid in the labeling of the goods, and a means of satisfying the consumer. A large department store is made up of an army of individual buyers, each responsible for the selection of certain categories of goods, sometimes only a certain price line in one kind of goods, such as women's dresses or suits. Sometimes the buyer will be responsible for garments in a certain size range, let us say, for children; another buyer will be responsible for the next larger group of sizes. Immediately a fundamental standard is apparent—the standardization of sizes of garments. One example was provided by the Textiles and Clothing Division, Bureau of Home Economics, of the United States Department of Agriculture, which in 1941 published the results of body measurements of American boys and girls based on some 147,000 American children, from which the ASA developed its height and girth system of sizes that so much more accurately fits children than the traditional age-size system.

Retailers are beginning to appreciate this kind of size standard as a guide, and we welcome the introduction of other size standards for patterns and for garments, not only for children but also for men and women. How much do our buyers contribute to the confusion of sizes and the increase of customer returns because of ill-fitting garments when they fall victim to the manufacturer's boast, "Of course, my garments are cut extra large"? On the other hand, they have often fallen victim to a particularly appealing low price made possible because the manufacturer skimped on his sizes, getting more garments out of a given yardage of cloth.

Then each selling season brings about its own new system of color description, new color cards for women's garments in particular. These colors must be standardized so that the customer can be completely outfitted in matching tones in each of the new season's colors. The matching ensemble of hat, scarf, suit, blouse, gloves, hosiery, shoes, or other accessories represents the selection of many buyers, some of whom are not conscious of the fact that in high fashion they are selling a standard, limited product, limited to the extent that no off-colors are offered to them by the manufacturers. Without such standard color cards, how could the mail order houses sell balanced ensembles from catalogs? How could the small retail merchant provide his customers with the new high fashion merchandise which would blend with shoes or hats or other accessories not purchased in his store?

BRAND NAMES

Many of our producers have said to retailers, "Our brand name is our bond of quality." To some extent this is true, particularly if the product lends itself to rigorous quality control during the manufacturing process. The quality control depends upon test methods and the manufacturer's own set of standards, if there are no industry-wide standards for the product. The manufacturer's brand name, however, is not infallible, for it is not at all unusual for a manufacturer, especially of textiles, to have a variety of price lines all bearing his own name. Then, too, there is the complication that a new element in the industry may be making a better product than the one that our customers have been used to buying. Retailers, as purchasing agents for their customers, are responsible for keeping up with new developments in the business and particularly for evaluating products that come out suddenly with the boast "new and improved" on their label. Garment manufacturing is such a complex business that few of the companies engaged in it really do much testing of the materials they use. For that reason, retailers must depend upon their own laboratory facilities and upon commercial testing laboratories in order to get a true evaluation of the serviceability, washability, colorfastness, and other consumer-use aspects of many textile products. To do this, we must have standards—not so much our own as those nationally recognized—and, therefore, we depend upon the American Standards, and upon the Commercial Standards and government purchasing specifications for much of our information.

NEW MATERIALS AND PRODUCTS

Added reasons for the use of standards for consumer goods are the ever-increasing flow of new materials, new textile fibers, new plastics, new metals, new finishes—the serviceability of which in the consumer's hands is unknown.

It is impossible to carry over the reputation of an old brand, identified with traditional materials, into the same brand of goods with the new materials of construction. A manufacturer of soaps, or of textile products, may from time to time vary the quality of his product as the cost of raw materials varies. Cheaper wood may be used in furniture if the cost of finer wood increases to the point where a reasonable profit cannot be made in the retail market. Electrical appliances may be varied from time to time depending, too, upon their cost of construction. Design changes in appliances may make the new products more or less efficient than those previously bought by our customers. New fibers in rugs may not reflect the manufacturer's usual position as far as quality of performance is concerned. The copyist in any industry is one who comes along and rides on the crest of the demand for a particularly good product. A copy may look like the original, which has been subjected to a considerable amount of testing both in the laboratory and perhaps even in the field. How, without standards, is the retailer to know which of the products is the better when both manufacturers may make the same claims?

Prospects and Problems

These are just a few of the retailers' stakes in standards for consumer goods. How will they use the standards?

BUYING AND SELLING GUIDES

First of all, standards will eventually be among the strongest buying guides. As buyers and merchandise managers become more accustomed to depending upon the services of the store's technical staff, or upon the commercial testing laboratory, and upon information supplied by such organizations as the ASA, retailers will use standards of quality more and more. The new must always be compared with the old in materials of construction and in techniques of manufacture. The information about the product should be more accurate when it is based upon standard test procedures than when based upon the manufacturer's or the advertising agency's claims. With the cost of sales distribution always increasing, this more accurate information will be useful on labels and tags, as aid to self-selection or better selling by our sales people.

Accordingly, we must have floors of quality of performance; that is, real standards based upon test methods as a framework guaranteeing our customers good service in use. If one product—perhaps the store's own private brand—has certain plus values over the minimum which has been adopted by the industry, then this is a plus value of which we can make a proud boast on our labels and in our advertising. This is what strong own-brands stores constantly seek, not only in their textiles but also in their paper products, their electrical appliances, their sporting goods, their hardware, their furniture—in fact everything they sell under such a program. Informative labeling can be based only upon facts and these, in turn, upon testing.

Retailers will use standards to keep goods sold. The key to this, of course, is satisfied customers. We must, therefore, supply our clientele with the information concerning the service which may be expected from the article and the care which must be given it in use. This will avoid many customer returns which are a steady drain upon retail profits and upon the pocketbooks of all our customers.

TEST METHODS

Standards of merchandise quality depend first of all upon uniform test methods. For these, retailers as well as producers rely upon the technical societies. The engineers, chemists, and physicists employed by manufacturers, by the government, by retail appraisal laboratories, and by commercial testing laboratories constitute the membership of the test-methods committees of such societies as the American Society of Refrigerating Engineers, the American Gas Association, the Underwriters' Laboratories, the American Society for Testing Materials, the American Association of Textile Chemists and Colorists, as well as the technical committees working under the auspices of the ASA and several government agencies. Unfortunately, such technical societies as the American Society for Testing Materials and the American Association of Textile Chemists and Colorists, on which the retailers depend for all of their textile standards, have shown great reluctance in committing themselves to developing performance standards for finished articles. They have been content to present their test methods as a basis for others to draw up performance standards. For example, the American Association of Textile Chemists and Colorists has developed standard test methods and ratings for the colorfastness of textiles entering into every kind of consumer end-use item, but not for the end-use items themselves. To cite one case, test methods appraise the effect of all the color-destroying agencies commonly associated with bathing suits, and it is possible to rate a fabric as to its performance, but there is no test for "a bathing suit." Similar situations are found in relation to plastics, metals, and other materials.

Despite these difficulties, much progress has been made and, within such organizations as the ASA, foresighted leaders among consumers, distributors, and manufacturers can sit down together and talk in a common language. Standards for consumer goods are gaining ever-widening acceptance as is evidenced by the ASA's programs in women's safety clothing (a wartime standard), in the size standardization of cooking utensils, in gas and electrical appliances used in the home, in photographic equipment, and notably, too, by the three big textile programs, the rayon, acetate, and other fiber standards. It has been a slow development, but I am convinced that standards have abundantly proved their worth. It is now only a question of the will to use them. It is a challenge to retailers to specify in their buying orders that the product conforms to whatever recognized standard exists for that particular item. Only then can the retailer convince the producer of his sincerity in supporting standards as buying aids. Furthermore, only in providing the ultimate consumer—the retail customer—with a certain proportion of goods bought on specification according to standards does the retailer accept the often repeated demands of consumer leaders. It is simply good business to recognize that if test methods and standards are good for the industrial purchaser they are equally as good for the ultimate consumer.

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25. STANDARDS FOR RATING CONSUMER GOODS

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PERHAPS some day a market place more rational than today's will permit the consumer to rely on those widely offered substitutes for quality standards: brand name and price. If the work of the consumer goods testing agencies has proved anything, however, it is that in the present market neither of these substitutes is a reliable one.

In such a market the job of the consumer testing agency is to help guide the consumer by appraising and rating products, not on the basis of brand name or price, but on the basis of the products' ability to perform satisfactorily the functions for which they are purchased.

Quality standards and standard methods of test are among the testing agency's tools. No test project is undertaken without a thorough search for applicable standards; and seldom is a laboratory test performed in which standard tests are not used to determine at least some qualities. If no standard methods are available for kitchen mixers, for example, there will at least be standard tests for measuring leakage current in the mixers. If there are no methods for testing men's shirts, there are standard methods for measuring the tensile strength and the shrinkage of the fabric.

It is not the writer's intention to give here a detailed accounting of the consumer goods standards used by a consumer testing agency. Let it be said only that they are far too few. The purpose, rather, is to present a picture of some aspects of a testing agency's work which could be aided by the cooperative enterprise of the many interests concerned through the application of standardization procedures. The organization with which the writer is associated is used in the following pages as a source of examples to illustrate many of the points made. It will be clear, however, that the principles apply to consumer goods testing in general.

RATING WITHOUT STANDARDS

It should, perhaps, be made clear at the start that the availability of standards for consumer goods is not essential to the work of a testing agency. Many products for which there are neither quality standards nor standard test methods are tested and rated. In the rating of automobiles, for example, whatever company standards a maker may use in design and production, so far as the buyer is concerned there are no standards to help him judge or measure the roadability, riding qualities, handling, steering, acceleration, durability, or safety of a car. He is given a horsepower figure which tells him something about accelerating and hill-climbing ability when the car is going, say, seventy miles an hour. How the car will behave on a variety of road surfaces, good and bad, how it will take curves, climb hills at ordinary speeds, or keep its grip on a slippery surface, he can find out only by buying the car and living with it; and he is unlikely ever to know, unless he has unusual opportunity to drive other makes of cars, whether his car is relatively good or bad in the particular characteristics that are important to him.

How does a testing agency compare and rate cars in the absence of performance standards and standardized tests? For the most part, by "seat-of-pants" methods. The cars are driven by men who have spent thousands of hours driving, who have driven from dozens to hundreds of cars, and who have been trained to a conscious awareness of many kinds of differences in performance and behavior. They are aided to a small extent by instruments, but no instruments can tell them as reliably as their senses how a car rides or holds the road, or how tiring it is to guide through traffic. One might say that, automotively speaking, they have the equivalent of the musician's "perfect pitch" permitting them to place an observed quality accurately on a measuring scale which exists in their minds.

There is, of course, no absolute reliability in such observations; but neither is there absolute reliability in measurements by instrument; and the seat-of-pants ratings do provide consumers with reasonably reliable information on which car to buy if they value comfortable ride above all else; which to buy for its ability to hold the road on bad surfaces and at high speeds; and so on.

TESTING UNDER USE CONDITIONS

The seat-of-pants approach has its equivalent in many of the tests made by a consumer testing agency. Whatever quality standards or laboratory test methods there may be, whether the product is can openers or television sets, whenever possible the products are set up and used in the laboratory under controlled conditions which give a reasonably close approximation of home use conditions. Automobiles offer the special difficulty that only a few cars are under test at the same time, therefore the need for "perfect pitch" in the comparison of subjectively determined qualities in cars tested months apart. With other products, where usually all of the products to be rated are present in the laboratory at the same time, comparisons can be made directly from one brand to another for each quality under study. Are the controls of a toaster difficult to set? It is easy to make comparisons with the other toasters in the project to see whether the actual differences in ease of setting, if any, are significant.

More seat-of-pants testing takes place when products are sent out for field test under typical home conditions. Generally, no radio, television set, or other household appliance, large and small, is given a high rating until it has been subjected to the rigors of ordinary home use. In most projects it is not feasible to subject all of the brands to home use tests; therefore only the brands which rate high in laboratory tests are sent out for home use. Field testing is done both as a check on the validity of the laboratory tests, and with the hope of bringing to light qualities not revealed by the laboratory tests. For example, home use of a test washing machine disclosed a problem the existence of which Consumers Union had not realized; in a home laundry, the machine gave trouble when there was sand in the clothes, such as might come from a beach or a sandy play area. Subsequent laboratory tests of all the machines, with measured amounts of sand added to the clothes load, showed that there were marked differences in the ability of the different machines to handle sand, with some of the machines relatively unsuitable for use in sandy locations.

RATINGS BASED ON FIELD TESTS

Those who question the validity of the work of the consumer testing agencies because of the paucity of quality standards and standard test methods should remember that such standards and tests have validity only if they permit reasonably accurate prediction of the behavior of products in actual use. Actual use is, therefore, not only a satisfactory substitute for standards and laboratory tests for determining the behavior of products, but can be a preferred method if field tests can be designed to permit valid comparisons. It is, however, seldom feasible to rate products on the basis of field tests alone; so many samples of each brand, so many testers, and so much time would be required that the project might be prohibitively expensive, and the elapsed time might be so great as to make the models rated obsolete.

Nevertheless, such tests sometimes offer the only recourse when standards and valid laboratory test methods are lacking. For example, children's shoes[1] were tested with the help of 238 boys and girls in four New England orphanages. These children wore the test shoes every day for twelve weeks, in good weather and bad, indoors and out, some in the country, others in the city. But a minimum of twelve pairs of each brand under test were tested to permit reasonably accurate brand ratings; the purchase of the shoes, the time required for careful fitting, for the detailed examination of each pair of shoes at intervals during the testing, and for tearing down the shoes at the conclusion of the test for the final examination, add up to a cost which makes a testing agency supported only by its subscribers wish that reliable laboratory test methods were available.

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[1] "Children's Shoes," *Consumers Reports,* Vol. 20, no. 4 (April 1955), pp. 152-8.

PAIRED-COMPARISON TESTS

A variation of the ordinary home-use method, and one which is employed increasingly in the absence of reliable laboratory test methods, is the paired-comparison method. Like the tests of children's shoes, where each child wore one pair of shoes for the duration of the test, the paired-comparison method requires careful statistical design and statistical analysis of the results. In such tests, many persons participate, enough so that with each person trying two brands, each brand in the project is directly compared at least once (preferably twice) with each other brand. Such a test is generally feasible only with relatively few brands (for each brand to be compared directly with each other brand, 45 pairs are required for 10 brands, 190 pairs for 20 brands, and 1225 pairs for 50 brands).

Consumers Union used the paired-comparison method in tests of can openers,[2] partly as a check on the validity of previously run laboratory tests. The tests were carried on in a store rented for the purpose in the business section of Amherst, Massachusetts. Each of the wall-type can openers in the project was mounted on a board which could be attached to a wall at any height convenient to the user. The townspeople of Amherst were invited in to open cans, each person trying two different openers, and telling which he preferred. (Four tons of beans in one-pound cans were bought for the test from a nearby cannery. Each participant opened at least six cans with each opener, and was invited to take home the cans he had opened. A good many cans were left behind by the testers and were made available to welfare agencies in the neighborhood.) Such a test tells little about the relative durability of the different openers, or about their effectiveness for cans of different shapes and sizes, but it does provide more information on relative ease and convenience of use than can be provided by an engineer's tests in a laboratory. (The laboratory did test cutters and driving wheels for hardness, and compared the hardness figures with Federal Specifications requirements for can openers. But since limited tests showed no correlation between hardness and durability—as measured by continued ability to open cans—hardness was not scored.) Razor blades, electric shavers, and many food products have been rated mainly on the basis of paired-comparison tests.

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[2] "Can Openers," *Consumer Reports*, Vol. 18, no. 8 (August 1953), pp. 338-42.

STANDARDS FOR PAIRED-COMPARISON TESTS

While the design of paired-comparison tests and the analysis of results ordinarily involves only straightforward statistical procedures, there is nevertheless need for research and standardization on the application of the method to various classes of products and to particular products. How much use of each product under what conditions is required for valid judgment and comparison? In a comparison of two different brands of food, for example, are a few tastes of each sufficient; or should a whole serving of each be eaten; or should each be eaten as part of a regular meal for several meals, as foods are normally eaten? What questions should be asked of each tester: simply which of the two brands he prefers, or the degree of preference (as slight or great), perhaps with evaluation of each brand in absolute terms (as excellent, good, fair, poor)? There is need for research, and for standardization to the extent that research shows standardization to be feasible. Why not an American Standards Association committee on paired (and other) comparison testing by panels of consumers?

The utility of consumer use tests, even at their crudest, provides another answer to those who doubt the validity of the work of consumer testing agencies either because of the absence of standards and tests or because of the seeming inadequacy of the size of the test sample. Perhaps the answer can best be indicated in the form of a question. Suppose a buyer were in the market for an automatic washing machine. And suppose that the buyer knew an intelligent housewife who had actually used in her own kitchen, each with several loads of clothes, the twelve leading washing machines on the market. Which would the buyer find more useful, the hyperbole of the advertisements and sales claims for the different washers? Or the housewife's off-the-cuff reactions as to ease of loading and unloading, ease of setting controls, ease of adding detergent, cleanness of the clothes, effectiveness of dryer, noisiness, etc.? Substitute, for the housewife, engineers able to examine and test all of the machines side by side under simulated home-use conditions, keeping accurate records of the behavior and operation of each machine, scoring each factor studied in terms of its effect on the utility and desirability of each machine. There is, of course, room for error, but even in the absence of standards and of a multiplicity of test samples of each model, there are enough differences in design and construction affecting performance and convenience to make purchase decisions based on such tests far more reliable than decisions based on brand name, price, advertising, or the chance recommendation of a neighbor or a salesman.

To say that tests and ratings based on little more than intelligent observation and obvious measurements offer better guidance for consumers than is to be found in the confusion of the market place does not mean that such tests and ratings are anything more than a stopgap until something better is available. Such ratings increase many fold the consumer's chances of getting relatively high quality. The ratings do not, of course, guarantee that the consumer will get the most for his money. But for a testing agency to refrain from rating products because it can only improve the consumer's chance of getting good value and not guarantee good value would hardly make sense. In fact, so long as manufacturers fall short of absolute quality control and make changes in their products without notice to buyers, and so long as consumers differ among themselves in their needs and their wants, no ratings will guarantee good value for everyone. The search is not for perfection, but for improvement; and here standardization can help.

METHODS OFTEN ARBITRARY

If the charge is made that when a testing agency rates products for which there are no generally accepted quality standards and test methods the rating is often unscientific and arbitrary, refutation of the charge would be difficult. Assuming that its use presents no extraordinary difficulties, a test method is good or bad depending on how well it permits prediction of performance of a product (or relative performance of a number of products) in actual use. To determine correlation with actual use, there exists no substitute for carefully controlled correlation studies. Several such studies have been carried out, but for most methods adequate correlation studies do not exist. In their absence, the decision to use a particular test method is based not on any precise weighing of evidence pro and con, but rather on the conviction that it is the best test available and that it is likely to provide significantly better guidance for the consumer than he would have if he went to the market without benefit of tests and ratings.

With many textile products, for example, it is assumed that, other things being equal, a fabric with higher tensile strength is superior to one with lower tensile strength; that relatively high abrasion resistance is desirable; that high thread count is better than low count; that relatively high resistance to the wearing action of laundering and ironing is an asset, and so on. Unfortunately, other things are seldom equal. The significance of balance of the various factors measured is difficult to comprehend; and there is always the possibility that other factors not measured, perhaps factors not even considered, are more important, as important, or under some circumstances, of overriding importance in determining how a product will perform in actual use.

TESTS THAT FAIL

A few years ago, for example, the laboratory staff of Consumers Union devised a test method for women's nail polishes[3] that seemed promising, and it was decided to test the leading brands. In the test, each polish was applied, just as it would be put on the nails, to a thin slab of ivory; the ivory was then subjected to flexing, immersion in soapy water, impact, and abrasion, in an effort to simulate what happens to nail polish in actual use. The test showed up clear and reproducible differences among brands, and it seemed reasonable to assume that a nail polish rating high in this test would perform better in actual use on women's nails than a polish rating low in the test. Nevertheless, ivory is not the substance of human nails, and laboratory-simulated use is not actual use; therefore it was decided to test the test by applying the polishes on women's nails. A professional manicurist was employed to apply the two polishes which ranked highest in the laboratory test and the two which ranked lowest to the nails of women volunteers, all of them housewives. The women were instructed to return to the manicurist for a second polish as soon as the first polish began to wear off. Of the four polishes use-tested in this way, the brand which had ranked highest in the laboratory tests was found to be the poorest, and the lowest-ranking brand in the laboratory test was found to be the best.

Some products have never been rated by testing agencies because of serious doubts about the reliability of available test methods; numerous products, however, are tested not because of absolute confidence in the test methods, but because there is reasonable certainty that the results will be meaningful. The gap between certainty and reasonable certainty can be narrowed, but it cannot be eliminated; that it is narrow enough to permit a product to be rated is one of the arbitrary decisions a testing agency must make. Standardization backed by sound research can narrow the gap and permit manufacturers, distributors, and others with legitimate interests in the decisions to help make them.

Only rarely is a test result the equivalent of a rating; few products are like household ammonia,[4] where for practical purposes, a single determination of the amount of ammonia gas present measures the relative worth of the product. For most products, many different qualities are measured. Before such a product can be rated, each quality must be assigned a score value indicating its importance to the consumer relative to all of the other qualities measured.

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[3] "On Nail Polishes and the Missing Link," *Consumer Reports,* Vol. 15, no. 2 (February 1950), pp. 52-3.

[4] "Ammonia," *Consumer Reports,* Vol. 18, no. 1 (January 1953), pp. 32-3.

THE PROBLEM OF SCORING

Scoring is one of the most difficult of the testing agency's jobs. Generally, the aim is to devise a system of relative scores that will reflect the needs and desires of an "average" consumer, whatever that is. The hope is that ratings based on the scores finally arrived at will reasonably reflect the needs and desires of most consumers. But any scores are of necessity highly arbitrary, and at best will hit wide of the mark for many consumers.

The scoring systems used by U. S. Government graders for canned fruits and vegetables illustrate the problem. The scores for canned pears[5] are typical. Gradations of flavor are not scored; if the flavor is not "normal," in the opinion of the grader, the pears are substandard. Odor, like flavor, is the subject of a go-no-go test. If it is "normal," the can may be graded A, B, or C, depending on other scorable characteristics; if odor is unsatisfactory the can is substandard.

The following are the factors scored, with the number of points allotted to each:

Character (meaning texture, ripeness, and tenderness)	30
Absence of defects	30
Color	20
Uniformity of size and symmetry	20

Probably half of the total maximum score relates to satisfactions not connected with appearance—satisfactions that would be derived by a person eating the pears while blindfolded. The other half goes for factors relating almost entirely to appearance. Like all scoring systems, those on which the official government grades for canned fruits and vegetables are based are largely arbitrary and are supposed to represent the trade point of view as to desirable characteristics.

SCORING COMPLEX PRODUCTS

But the scoring problems faced by the government grading service seem trivial when compared with those encountered with more complex consumer goods. Consumers Union recently had its paint consultants test and score alkyd flat paints.[6] The consultants were concerned solely with the properties which affect the ease of application of a paint, and its appearance and performance after it has been applied. For their judgments, it was necessary for them to determine the following properties of each paint: initial viscosity, fineness of grind of pigment, skin formation, liquid separation, settling of pigment, ease of redispersion, viscosity stability, odor, ease of brushing, lapping, set to touch, hard drying time, leveling, sagging, sheen uniformity, color uniformity, flashing, flooding, opacity, reflectance, stain removal, film break, scrub resistance, resistance to abrasion, resistance to water spotting, flexibility, adhesion, mar resistance, and color change.

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[5] U. S. Standards for Grades of Canned Pears (effective December 1, 1951), Production and Marketing Administration, U. S. Department of Agriculture.

[6] "Alkyd Wall Paints," *Consumer Reports*, Vol. 20, no. 6 (June 1955), pp. 269-72.

What percentage of the total score should be allotted to each of these factors? What is the relative importance of, say, easy brushing as against good opacity or covering power? The answers in terms of these factors and many others would be different not only for different painters but for different jobs done by the same painter. An amateur painter with the skill of a professional might not be concerned about lapping; the inexperienced painter might be unable to do an acceptable job with a paint that tends to show where successive painted areas overlap. Opacity might be of overriding importance to the painter who lacked the time or the inclination to apply more than one coat; on another job, say in a child's room, the same painter might consider ease of stain removal much more important than opacity.

It would be easy at this point to throw in the sponge, to tell the consumer to go read the advertisements, and make up his mind for himself. But the fact is that there are great differences in paints as in other products, differences not revealed by advertising claims, brand name, or price; and that the arbitrary assignment of small relative scores to each of the many factors does reveal significant differences in over-all quality. And since the nonprofessional painter lacks the opportunity of comparing different brands to make any kind of determination of his own preferences, ratings based on the scoring scheme at the least increase greatly the probability that he will get a good paint.

For the consumer who is willing to take the trouble to read, the rating agency offers more than the information that a particular paint is the over-all "best." As part of each rating, there is a breakdown of the principal properties entering into it; for example, ease of application, covering power, drying time, etc. With this additional information, the buyer need not limit himself to the brand at the top of the list, but can choose from among a number of brands relatively high in over-all quality one which is outstanding in the special quality he needs, whether it is covering power, ease of stain removal, or something else.

The number of factors, and the particular factors, scored in the rating of paints illustrate another of the compromises made by a rating agency, and reflect some of its problems. With a good performance test, there should be no need for consideration of factors which are matters of paint formulation and are important only insofar as they affect performance. But a performance test done in the laboratory, however good it may be, is not long-term use under the variety of conditions met in the field; therefore scores are given to factors which may affect ultimate performance in ways not immediately and perceptibly evident in the performance tests.

SCORING REFRIGERATOR CHARACTERISTICS

Electric refrigerators provide another example of the complexity of the scoring problem. Wherein do refrigerators differ in their performance and in the satisfaction they will give their owners? Obviously they should keep foods cold enough to prevent spoilage; but even on this factor there is no general agreement among the experts as to optimum coldness. There has been a tendency in recent years to provide for increasingly lower main-space temperatures, with the average temperature kept only enough above the freezing point to prevent freeze-ups resulting from temperature fluctuations. In a recent series of tests by Consumers Union[7] it was decided to use main-space temperatures of 37° at an ambient of 70°, and 39° at an ambient of 90°, as standardized test temperatures, and all refrigerators with adjustable controls were set to maintain these temperatures. But the figures represent average temperatures. How much fluctuation in normal cycling should be permitted from this average to avoid penalty; and how much should refrigerators without adjustable controls be penalized for average temperatures somewhat higher than these? Such questions mark only the beginning of the problem.

A modern refrigerator has, in addition to its main space, a space for the storage of frozen foods. A temperature no higher than 5° F. would seem to be desirable in the freezer compartment; below 5°, most frozen foods can be kept for months without deterioration. But the freezer compartments of some refrigerators go no lower than about 15°; obviously they were intended by the manufacturers for storage of frozen foods for no more than a few weeks at a time. Should such refrigerators be penalized because some owners are sure to leave frozen food packages in the freezers for longer periods? If they are to be penalized, how much? No freezer provides uniform temperatures in all parts of the loaded compartment. Many freezers have "warm" spots, some more than 20° above the average. How much variation is permissible, and how much should excessive variation be penalized? Rapid ice-cube freezing is a convenience; of a total score of 100 for all factors, how much is the convenience worth? Main-space and freezer temperatures at lowest control setting at an ambient of 110° were determined as a measure of the reserve capacity of the refrigerator; how much score is such reserve capacity worth?

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[7] "Refrigerators," *Consumer Reports,* Vol. 19, no. 9 (September 1954), pp. 396-408.

And what about relative operating cost? Purchase price should never enter into order-of-quality ratings of products of any kind. But the question remains, should the cost of the electricity to operate a refrigerator be regarded in the same light as initial purchase cost, and not scored; or should it enter into the quality score? And if so, with what maximum score?

SCORING CONVENIENCE FACTORS

The problems are difficult, and because each permits of a variety of answers with no one correct answer, the decisions must be largely arbitrary. But these problems represent only a part of the complex of factors affecting the buyer's satisfaction with his purchase. How easily can a variety of sizes and shapes of food containers be placed in the refrigerator, and after they are inside, how easy is it to see them and get at them? Some main-space shelves are easily knocked from their supports; how much should shelf stability be scored? Are the depths of the shelves, the number of shelves, the presence of folding shelves and adjustable shelf spacing scorable factors? Certainly all will affect convenience of use and therefore the user's satisfaction with his purchase. Should there be a bonus if the shelves slide in and out; and should there be a further bonus for positive stops that keep them from sliding out too far? Should there be a score for grid spacing in the shelves, since too-widely-spaced grids may make the upright storage of very small containers difficult? If defrosting is not automatic, or if automatic defrosting requires the emptying of trays, should inconvenience of defrosting be penalized? Some refrigerators are much noisier than others; should a noise score enter into the rating?

Another problem area concerns features present in some refrigerators and not in others. Should large crisper space be considered a scorable advantage; or is it a disadvantage because it cuts down general storage space? Most refrigerators have egg shelves; should egg shelves readily removable for cleaning get extra credit? And what about special butter compartments, cheese compartments, and drink compartments? Should the ease of opening the door or doors (some have separate doors for the freezer compartments) be scored? In some refrigerators the interior light bulb is not well protected against accidental breakage; how much should such lack be penalized? And so on.

PERFORMANCE VS. CONVENIENCE

In theory at least, all, or nearly all of these factors affect the user's satisfaction and should be scored for the final rating. It has been argued that since most modern electric refrigerators will do an adequate job of food keeping (whether they will or not depends largely on how long a particular user keeps foods in the refrigerator), convenience should be scored much higher than performance. While the technical staff did not go this far, they did conclude that convenience was as important to the average user as performance and that convenience factors should receive about half of the total score. Since the judgments of engineers on the relative convenience of different refrigerators were not considered reliable, however, it was decided to use a jury of housewives. Each juror, going back and forth from one test refrigerator to another in the laboratory, and judging independently of the other jurors, wrote down her judgments of the various features of each model, and her over-all preferences. Milk containers, cans, jars, vegetables, and other items were supplied to help her judge convenience.

The results showed little agreement among the housewives; what some liked, others disliked; what some considered indispensable, others judged intolerable. The confusion of judgments emerging from this test is not, of course, an indictment of jury testing, but only of the kind of test used. Too much was expected of the housewives in ability to distill from a few hours observation of some thirty refrigerators knowledge actually obtainable only from weeks or months of use of particular refrigerators in their kitchens. Here is a product that practically demands paired-comparison tests, with each participating housewife trying two competing models alternately, each for perhaps a month at a time. Unfortunately such tests, on the scale required for ratings of relative convenience, are too costly for a rating agency.

A final compromise was to assign 75 of the 100 score points to performance factors, and 25 to convenience; and with the 25, to score only those convenience (or related) factors which probably everyone wants. For example, 3 points were allotted to stability of shelves; no one wants unstable shelves. Five points were allotted to the kind of adjustability that would permit the user to change the spacing of the shelves to meet his particular requirements. Quietness of starting and running was scored 5 points, ease of defrosting, 5 points. Since it was believed that egg shelves removable for cleaning added a little to the desirability of a refrigerator this factor was given one point, with another point for egg shelves that would hold all sizes of eggs securely (not all did). No score was given for the amount of crisper space, but a maximum of 3 points went to convenience of use of crispers, a factor in which the refregerators differed greatly. For condensers which did not require periodic cleaning, there were 2 points. The final score values for all factors were arrived at only after much study and many long conferences; no other group of people, or even the same group at another time would arrive at precisely the same result except by chance.

SCORING AND RATING

Lest it be argued that the scores noted above are completely irrational, it should be pointed out that with the particular scoring method used, the relative scores are affected not only by the judgments of the relative importance of the different factors to the consumer but also by the nature of the differences between brands for each factor. An important factor may be scored low because on that factor there is little to choose between different brands.

Along with the decision to score only the convenience factors noted above went a decision as to other factors—a common one in a rating agency's experience with scoring: don't score it, describe it. Thus, there was no score for the number of shelves or the presence of a cheese compartment. On such things, the difficult job of deciding what is best for him is handed to the prospective buyer. A typical refrigerator rating illustrates some of the problems both of the rating agency and of the conscientious consumer who has to interpret the information provided to make a choice in terms of his own needs. It will be noted that the rating which follows mentions a number of factors discussed in the text accompanying the ratings but not touched on here.

> Brand A. $525.56. 11.4 cu. ft. total. Two doors; 2.5 cu. ft. freezer average 3° F. Main space cooled by finned cold coil. Single temperature control for main space and freezer. Good regulation of refrigerator temperature with changes in room temperature. Ice freezing slightly faster than average; slight freeze-up hazard in main space. Defrosts during each cycle; melt water collects in heated evaporating pan. Two full sliding shelves judged somewhat flimsy; one fixed shelf with removable half, one folding quarter shelf. Three shelves in main door and one in freezer door; removable holder for eggs; heated butter compartment; left-over containers. Two enameled metal crispers. Light in freezer as well as main space. Four ice trays. Very quiet. Available with left hand door opening for $4.75 extra.

The refrigerator ratings also show another difficulty of consumer testing, particularly of durable goods: the absence of any scoring of the probability of trouble-free operation and of durability. While occasionally a fault of material or design likely to cause trouble is noted during laboratory tests or comes to light in home use tests, with many products the knowledge that can be brought to bear at the present stage of development of consumer goods testing does not permit the scoring of durability. (Consumers Union has used its annual subscriber questionnaire as a source of data on previous years' models of automobiles, and includes information based on the data with the ratings of new models, for what it is worth. About 100,000 subscribers owning automobiles report the repair records of their cars for a number of specified repair operations.

Experiments in gathering similar data for household appliances have not been very productive).

HELP WANTED

This recital of problems encountered by a testing agency is set down here not to elicit sympathy, even though the problems sometimes seem overwhelming; rather it is to point up the need for aid by other qualified agencies, primarily through the standardization process. Few of the testing agencies' technical problems, from brand sampling to rating, are outside the orbit of cooperative approaches to solutions under the aegis of standardization agencies.

The reports of the testing agencies are read by many hundreds of thousands of families in the United States. According to a study by Eugene Beem,[8] they influence directly the expenditures of families with a total income on the order of $15 billion. There is a growing volume of evidence that their impact on the sales of some companies has been great enough to cause serious concern.[9] Correspondence from manufacturers of unfavorably rated products does include an occasional suggestion that a different test method should have been used, or that desirable qualities present in one product but not in others had been overlooked. Some of the technically advanced companies have offered to consult on test methods and to demonstrate their own methods, and some have been generous in sharing technical knowledge even, at times, when it reflected unfavorably on their own products. But not once has there been the suggestion that the groups concerned join, through the ASA or otherwise, to help lay the broad groundwork on which the rating agencies base their tests and ratings. Yet such a groundwork, laid on a foundation of sound research, is desirable for the protection of manufacturers as well as consumers.

THE NEED FOR RESEARCH

A test method or a quality standard is seldom better than the research that goes into it. But the kinds of research needed for many products could best be provided by a pooling of the resources of all who have an interest in the products. Nor can research on any product be a one-shot affair. Products change, and as the products change, so do the wishes, and ultimately the needs, of consumers. There was hardly need for tests of frozen food compartments of refrigerators, for example, before the advent of frozen foods made such compartments first a desirable added convenience and then a necessity. As new designs, new finishes, and new

[8] Eugene R. Beem, "Consumer Financed Testing and Rating Agencies in the United States," doctoral dissertation, University of Pennsylvania, 1951.

[9] Eugene R. Beem and John S. Ewing, "Business Appraises Consumer Testing Agencies," *Harvard Business Review,* Vol. 32, no. 2 (March-April 1954), pp. 113-26.

features are added, or as new knowledge of the old is gained, the tests and the standards need reworking; and such reworking requires continued research, not only in the engineering laboratories but also in the scientific laboratories.

For the development of both test methods and scoring systems, research is also needed on consumers' needs, wants, and especially dissatisfactions. The work done by the Survey Research Center at the University of Michigan and others on the motivations behind purchase decisions might well be extended to cover more specific exploration of the three factors mentioned: What does the consumer *need* in a product, in terms of the use he makes of it? (The consumer of an automobile needs good brakes, to take an obvious example, though it might not occur to him to compare the brakes in different automobiles.) What does the consumer *want* in a product beyond what he needs? (Consumers want high-powered automobile engines, a questionable need at best.) What makes a consumer *dissatisfied* with a product, so that he will replace it if possible and be unhappy with it if he cannot afford to replace it? (A washing machine that tears clothes would be an example.) It may well be that potentially dissatisfying factors should receive much greater weight in scoring systems for consumer goods than they generally do. The housewife may be actively unhappy with a washing machine, for example, because it rips clothes occasionally or vibrates enough to shake the house; but she may be quite indifferent to the fact that it can get 10 per cent more dirt out of very dirty clothes than another machine.

FOR THE MAXIMUM NUMBER

Obviously no amount of research will generate a scoring system suited to all consumers; fairness to both consumers and industry, however, suggests the desirability of a scoring system keyed to the requirements of the largest possible group of potential buyers. Standard scoring systems based on carefully and broadly collected data should in time replace the systems based on more or less informed guesses. It is now possible for two consumer testing agencies to use precisely the same test method on the same brands, come up with the same test data, and then, because of scoring differences, to give grossly conflicting ratings to the same brands.

When research is done on consumer requirements, it is to be hoped that its focus will not be principally on the qualities that make consumers select a product, but rather on the qualities that affect his satisfaction with the product's performance of its function. Such factors as the length or shape of an automobile hardly belong in a scoring system; but the way the automobile rides and holds the road do belong there.

It should be recorded here that Consumers Union does not use formal scoring systems for all products, though the exceptions are rare; it should also be recorded that the effort is made to avoid excessive rigidity in the application of scoring systems. When a range of scores is believed not to represent significant differences between brands, for example, all of the brands within the range are rated as being of approximately equal quality. Where ratings are based on paired-comparison tests which reveal only the over-all preferences of the participating group of consumers, then, of course, there is no scoring problem and there are no scores.

THE USE OF EXISTING STANDARDS

Space permits only a brief final statement about the testing agency's use of generally accepted standards for consumer goods. Such standards are used wherever possible. Sometimes an existing standard is used, though reluctantly, as the best measuring rod available, with the knowledge that the lack of research to establish its validity makes it an uncertain one. The government standards for grades of canned fruits and vegetables are examples of such standards. At the same time, however, these government standards are examples of an almost ideal kind of standard from the point of view of the testing agency; they separate the standard products from the substandard; and they provide benchmarks to divide the above-standard products into different grades. Like many other standards, they include test methods, but in addition they contain precise scoring systems. It will be a great day for the testing agencies when in all fields there are standards like these (but a greater day when the standards are based on much better research than these are).

For want of better, some Federal Specifications[10] are used as quality standards on the theory that a product not acceptable to government purchasers for use by government agencies is not acceptable for consumers. The Federal Specifications also have the virtue of specifying test methods. Dentifrices are among the products rated in large part in terms of Federal Specifications, and the glass-slide scratch test of the Specifications has probably saved a great many teeth from being excessively abraded. Federal Specifications have been used, at least in part, for tests of floor waxes, cleansers, and various textile products. But because the Specifications and the accompanying test methods are not primarily consumer oriented, and also because they are seldom based on the amount and kind of research needed for good consumer standards, their usefulness is limited. American Standards for consumer goods[11] are not abundant; where they exist, they are generally used, though they may be modified in terms of consumer requirements.

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[10] *Index of Federal Specifications and Standards.* Federal Supply Service, General Services Administration, January 1, 1955, and monthly cumulative supplements.

[11] *Price List and Index, American Standards, Spring 1955,* New York: American Standards Association.

From the point of view of the rating agency—to summarize—there is need for organized, cooperative effort to further research on consumer requirements for many kinds of consumer goods; and to develop quality standards, standard test methods, and standard scoring systems, and ultimately, perhaps, broadly-agreed-upon standards for rating consumer goods.

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PART III

Some Implications of the Use of National and International Standards

26. SIGNIFICANCE OF COMPANY AND NATIONAL STANDARDS TO INDUSTRIAL MANAGEMENT

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STANDARDS AND THE ECONOMY

THE EXTENT of our material well-being can be gauged by statistics that are given from time to time on the number of telephones, radios, television sets, automobiles, bath tubs, and other items that are produced for our use. In explanation of the quantities of these products that are available, we generally think in terms of the application of power and machines to increase the fruits of our labor, and we think of mass-production and assembly-line methods to produce more goods for more people at less cost.

Actually these accomplishments are the result of good management in a free enterprise economy that recognizes standards and standardization as motivating forces in industry. Standards and standardization are keys to increased future possibilities for those who do not take standards for granted because of their past gradual evolution and who can visualize the potential uses and benefits that are obtainable.

If we consider for a moment the chief advantages of standardization and standards, we can only conclude that they are important processes and tools for the best application of our collective store of knowledge, for stimulating research to find better ways of doing things, for recognizing areas of common interest, and for finding the best methods to accomplish our purposes. They serve, therefore, to notch up, consolidate, communicate, compare, and measure our progress. They are a means to simplify practice, to coordinate and conserve effort, and to help utilize more efficiently our knowledge and resources to the best advantage. They liberalize man-hours that otherwise are engaged constantly in reinventing the wheel. To us in industry they are essential to increase economy and productivity, to lower costs, and hence provide more goods and services needed or desired by society.

Standards and Industrial Management

Whether or not we recognize and appreciate the value of standards, we have them with us, and they will continue to accumulate. We have the choice of two paths: (1) the haphazard accumulation of standards forced upon us by society or economic necessity as has been the case so often in the past, or (2) the planned development and application of standards as matters of good judgment and good business management.

HAPHAZARD DEVELOPMENT OF STANDARDS

The lack of common standards on screw threads and fasteners faced by the Allies in World War II cost hundreds of millions of dollars and nearly resulted in the loss of North Africa. American-made tanks remained immobilized because British-made fasteners in Egyptian stores were not interchangeable and hence not usable for repair of battle damage. It took two world wars and the current needs for mutual defense to stimulate necessary action. None the less significant in their aggregate value to industry are numerous though less dramatic examples. ASA project Z55 was initiated to eliminate if possible the dissatisfaction and economic waste in the present use of hundreds of gray colors on industrial apparatus and equipment. Without industry standardization, individual company effort was ineffective to cope with the excessive variety of grays selected by designers or specified by customers. Here again standardization was not undertaken until the situation became serious in many companies. Innumerable examples might be cited in respect to company standardization on a delayed emergency basis. In one instance standardization and simplification of studs were undertaken after 10,000 individual stud drawings had been accumulated with obvious waste of drafting effort and manufacturing expense.

PLANNED DEVELOPMENT OF STANDARDS

In contrast with this kind of procedure which undoubtedly cannot be eliminated entirely, abundant opportunity exists at all standardization levels for the planned development and application of standards. Instead of assuming that standardization is something deserving attention only when mass production is attained, it must be realized that standardization is a prerequisite of mass production with a relationship as close as that of the hen and the egg. Since the opportunities for standardization are so closely associated with our regular duties, they are likely to be overlooked entirely. It might be desirable, therefore, to take a more inquisitive look at our ordinary procedures to examine possibilities for planned standardization on a broad scale.

Company Standards

Every designer has the job not only of determining the general proportions of a part or product but also of selecting and specifying materials and components, with complete dimensional and constructional detail to suit required methods of fabrication. He must take into account the performance requirements of the part or product, economic considerations for purchasing, processing, and inspecting raw materials, and other factory considerations for appropriate manufacture and assembly.

It is not surprising to find that every designer must search for information in vendors' catalogs, trade magazines, and other sources, and compile his own "bible" of information for his purposes. The questions might be asked: Is this the proper method to conserve effort so that it can be used principally for creative purposes in solving new problems? Is this the responsibility and fault of the designer or of business management? Consideration might well be given in any company to some standard procedure to seek, compile, and maintain an authoritative source of standards information pertinent to a company's business for more efficient employment of designers' talents.

It is not uncommon to have a drawing prepared and put into the factory only to find that the design is not suitable for the process required for the production quantity, that materials are not suitable for their purpose or available in the small amounts needed, that tolerances are not realistic in respect to those that might normally be expected from available machine tools and operators, or that other specifications are incomplete, incorrect, or confusing. Too often the parts and products must be redesigned to make them practical for manufacture or to improve them for performance, cost reduction, or service purposes. Where such conditions prevail, there is a need for some planned procedure to review problems of mutual interest and concern to engineering, manufacturing, and purchasing departments to avoid instances of this kind.

In mass production because of the risk involved, it is usually an economic necessity for specialists in product design, tool and equipment design, factory layout, production planning, processing, purchasing, and inspection to review a proposed design in all of its constructional details before releasing it to manufacture. This is not considered necessarily as standardization but rather as their normal job. It is probable that solutions to particular problems are recorded as a matter of course to avoid the necessity for repeating the same work for succeeding models or devices. It is probable also that records are made of materials, dimensions, construction and uses of common parts, or of practices found beneficial by experience. These records of solutions to recurring problems are standards.

In smaller operations the same basic need exists, but the concentration of time and effort on the review process might not be warranted. A similar purpose can be served by the assignment of responsibility and accountability to a competent technical individual to review repetitive problems with the various specialized functions involved, and to prepare necessary company standards.

An immediate reaction might be that production is too small to justify assignment of personnel to such work. In that case further study may be warranted. It might be asked if the end products differ from one another in some minor detail, or if there are certain parts or subassemblies that are or could be made the same to increase production quantities and yet permit assembly in various combinations. It might also be asked if there are machine tools that are being operated continuously one, two, or three shifts a day or if other operations are repetitive day in and day out. If there are, it is a fair assumption that there is mass production at some process level even in a job shop operation.

It is also probable that in most companies too many grades and sizes of materials are specified, and that there is unnecessary variety of purchased components, or other superfluous items that could be reduced and simplified for greater economy in purchase, acceptance, and processing. The management of one company using millions of pounds of certain material discovered to its amazement that the three most frequent purchase quantities were 100, 500, and 50 pounds respectively—due entirely to the excessive number of sizes specified by the company's designers. Extra costs, because of small quantities, amounted to approximately 5 per cent of the total raw material costs. In cases of this kind even fractional improvement provides an attractive return on liberal investment in standardization. Additional advantages also accrue in better and more consistent quality, economy in employee training, increased operator skill, less need for inspection and supervision, fewer setups, possible application of improved tools, and the like. These are some of the possible uses of planned company standards to conserve effort, lower costs, improve quality and service, and increase productivity. Such standards can mark the path to better profit margins, better competitive position, expansion of markets, improvement of tools, and to mass production if sufficient need or desire for the product or service exists or can be created.

Capital is risked in business ventures, but there is some doubt if it is employed sufficiently in grass roots activity that can play such a vital part in making success probable. Instead, it is likely that thoughts of management are fixed on the company's finished commercial product. A profitable opportunity generally exists, therefore, for a company standards group to determine and analyze the company standards requirements, become familiar with and aid selection from industry and national standards, participate in the development of new outside standards, and develop or secure development and application of additional internal standards that are often needed to meet specialized company requirements.

More might be said about the internal company aspects of standards and standardization, but the record would also seem to warrant an enlightened review of product, industry, and national standards. Before a product is designed, thought is usually given by progressive management to the kinds of products a customer wants, the extent and potential of the market, the function to be performed, the performance characteristics and quality required, and the economics involved. Some question arises if suitable attention is given at that stage to product and industry standards. Without attempting to trace the history of any product standardization, instances can be recalled where products were put on the market with the introduction of sizes and capacities to suit individual applications indiscriminately as they arise and without regard for the inevitable future need for simplification.

Product Standards

If a product uncovers a potentially attractive and profitable market, competition springs up and is stimulated by customers. It is commonplace to find the introduction of odd sizes or intentional differences in design to make products functionally or dimensionally noninterchangeable. In a new and unknown technical field intentional differences might be a necessary cut-and-try method for determining the most desirable sizes and performance characteristics prior to any standardization effort. In the case of short-lived products such differences might serve a useful purpose in progressively developing the most convenient and desirable features. In many cases, however, introduction of noninterchangeable features results in accumulation by all companies in an industry of a superfluous variety that can only reduce production quantities per item, lower profit margins, hinder application, increase service difficulties, and hence lead to the situation where standardization and simplification are the only remedy with resultant obsolescence, dislocations, and expense. This has happened so many times that the process and consequence too often are associated unfavorably in people's minds with standardization.

Much unnecessary complication of this kind can be avoided by introducing standardization in the planning stage. Preferred numbers in American Standard Z17.1 can be a useful standardization tool for the logical selection of sizes, capacities, mounting dimensions, and other technical characteristics. By keeping individually alert to signs of common interest and general welfare, and by independently working toward the development of general industry standards, a manufacturer can do much to eliminate economic waste, accelerate the ordinary development of a product business on both a company and industry basis, and assist in the most widespread and effective utilization of the products in question. It is possible that some products fail to serve their purpose to their rightful extent because of lack of interchangeability in dimensional or other respects. Others perhaps are retarded for lack of a broader base of availability, definition of characteristics, or standards for their application. On the other hand whole industries, for example, radio and television, have developed and matured in relatively few years because of initial industry-wide planned standardization.

Industry Standards

It would be prudent for the management of any business to appraise its degree of self-sufficiency, the extent to which it can progress without similar progress in its trade, and its stake and activity in trade standards. As explained by one industry association, its standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser in selecting and obtaining the proper product for his particular need, without in any way precluding any manufacturer from manufacturing or selling products not conforming to the standard. Such standards define products, processes, and procedures with respect to nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing, and the service for which designed. As a typical example, one industry standardized the mounting dimensions of its products, thereby effecting interchangeability and stimulating wider application. It might be observed also that the development and publication of industry standards often lead to national standardization when other groups are stimulated to contribute additional information on their requirements or on their experience in application. This procedure tends to improve products and refine and broaden standards.

In addition to this phase of industry standardization, a company might also explore common interests in its trade in respect to national standards activities relating to equipment, production materials, supplies, or practices, to determine the possible need for developing a trade viewpoint which perhaps should be considered, reflected, and represented.

National Standards

National standards comprise subjects of interest to different groups where a consensus of all concerned is necessary or beneficial. Some of these include commercial products and services whereas others are of a basic technical nature. The latter are usually developed under the sponsorship of technical societies and are important since industry depends upon new technical knowledge for the improvement of its products and for expansion in new technical fields. The industry needs the broad technical standards that are included in the objectives and accomplishments of such societies as a means of consolidating technical knowledge and putting it to work. While much has been done to develop and establish fundamental terms and characteristics, define them, and make them measurable, there is a continuing need not only in new fields but also in many existing areas for essential standardization of this kind. It is difficult to imagine the state of the electrical business without the fundamental definitions that have been established, as well as without other standards that make possible the interconnection and application of equipment to generate, transform, transmit, and utilize electric power. Without such recognized terms and definitions, common understanding cannot exist, and often as a consequence cut-and-try methods or instructions on detailed procedures are still necessary in lieu of the specification of requirements, performance, or quality in qualitative terms. Such is the case for many chemical products because characteristics significant in their application have not been identified, defined, and made measurable.

International Standards

In suggesting possible directions to look for standardizing activities that can be beneficial to a company, international standardization should not be overlooked by any company active in the export business. Differences in standards of definitions, methods of rating, and other conditions can be serious obstacles. Business has been lost to foreign competition, for example, because of the American practice of determining the capacity of certain products with a permissible temperature rise of 55° C. whereas international standards permitted a 65° rise, and hence quotations could be made on smaller and less expensive equipment for the same application. Instances might also be cited where orders have been taken on products required to conform to international standards recommendations with the result that on delivery it has been found that American practice differed and that our products were not acceptable under foreign contracts. It might be desirable, therefore, to consult the ASA about international standards of possible interest to a business.

CONCLUSION

Industry has tremendous responsibility, particularly under the free enterprise system, for offering an ever-increasing amount of goods and services, providing more and steadier jobs, increasing the real income of its workers, and generally fulfilling its purpose in society in an intelligent and responsible manner. In the next ten years, assuming that present trends continue, the gross national product should increase about 33⅓ per cent. Undoubtedly the trends reflect some degree of improved efficiency because of increasing activity in standardization. The gross national product could be increased to a much greater extent if adequate attention were really given to the conservation of creative effort, more efficient application of human and material resources, and better understanding and coordination. Standardization can help substantially in accomplishing just such purposes, since it is a method for the systematic compilation and arrangement of data and for the application of judgment by all who have an interest and can contribute to the most satisfactory solution of our daily problems.

The work of every president of a company and every general manager of a component is, basically, to plan, organize, integrate, and measure accomplishment for the most useful and efficient application of the company's resources in the conduct of its business for the benefit of society. This cannot be done in the present machine age without recognizing the need for standards and standardization and planning for them in proportion to the existing or potential size and complexity of the business operation.

The alternative is in the direction of executive attention to detail, faulty accomplishment, inefficiency, degradation of talent, irresponsibility, legislated solutions, maintenance or stimulation of confusion, and general contribution to maladjustment of our industrial machine.

Standardization and standards are not the beginning and end of all industrial problems, but they most nearly reflect the philosophy of good business in endeavors to find the best answers to problems when questions of judgment and common interest are involved. Power and momentum for expanded industry and better living can emerge in the vigorous pursuit of standards and standardization because of their major contribution to lower costs and prices, to incentive for wider application, and hence to more and better products and services. Evidence is abundant in past accomplishments—the future is full of still further needs and desires.

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27. LABOR USES STANDARDS

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ESTABLISHING standards is a major purpose of a labor union. Anyone who examines and compares wage rates, work loads, promotions, lay-offs, rehires, and other working conditions in organized and unorganized plants will see what I mean.

Where a union performs its functions for workers, wage rates will be spelled out for each job classification, overtime rates and night-shift premiums will be fixed, the physical and operating conditions under which work will be done (safety standards) will be defined, the amount of work to be done will be determined by agreement, promotions and lay-offs will be governed by rules of seniority, grievances will be handled under procedures specified in the contract and interpreted by arbitrators' decisions. At almost every step standards will have been arrived at by agreement between management and labor to provide bench marks of performance, both ways.

Unorganized workers have no such standards to protect them. When wage rates and the conditions of work are determined solely by the employer, he may change them at will. Though he may proclaim high standards, he may take them away when he wishes. Wage rates, work loads, promotions, lay-offs and rehires can be, and often are, arbitrary, discriminatory, or simply capricious, conforming only to the whims and prejudices of those who speak for management.

Lack of wage and job standards in the unorganized shop is the most powerful reason why workers organize. They want to have these things spelled out, and to have an equal voice in the spelling. Favoritism on wages and promotions, speed-up of workers on the job, displacement of workers at forty by raw recruits not yet broken in body were vigorous incentives in the bitter and sometimes bloody struggle for recognition. For the jungle law that prevailed in our basic industries in the days of the open shop, union contracts substituted civilized codes which define, as standards, the rights of both workers and management under the contract between them.

If anyone seeks proof of the benefits that accepted standards can bring to human relations, I would suggest that this basic transformation of the status of the individual worker in the complex life of a mass-production industry affords opportunity for rewarding research. The revolution wrought by machinery is widely recognized. The marvels of productivity and reduced cost achieved by our mass-production techniques in which industrial standards have played an important role are a national boast. Of course, labor, along with the country as a whole, has gained a great deal from all this. But scarcely recognized, outside of the plant itself, is the revolution in human status and stature which collective bargaining has accomplished through the introduction of enforceable rules to the labor-management relationship.

Since the first steam engine was put to work, the question that has plagued the Western world is whether men are born to serve the machine or machines are made to serve men. As technology enlarged the opportunities for substituting machine power for manpower, the rule of the machine and its owner over the worker became more imperious. Invention of the production line intensified that particular form of machine tyranny known as the speed-up. When twenty-five years ago, there was added to this the demonstrated failure of our highly mechanized society to serve men by providing to people generally the means of buying what the machines were capable of producing, labor organized the mass-production industries. Standards defining the superior rights of men over machines were written into contracts and into laws.

The evidence is overwhelming that this victory of men over machines has enormously enlarged the productive power of the machine. Free men are more productive than slaves. But the victory was less than total victory. We have still to demonstrate that we can match the machine's power to produce goods with a social and economic system that will enable us to consume those goods. And while office holders and legislators hesitate in their approach to this basic problem the new techniques of automation enormously enlarge the dangers on this score. That is why organized labor in 1955 broke new ground in collective bargaining by establishing the right of workers to the guaranteed annual wage. Our purpose was to set new standards in the labor-management field that would define the rights of workers to steady employment and stable income, and impose upon management a responsibility to manage with an eye to mass purchasing power as well as mass production.

I am not sure that the collective-bargaining standards I have been discussing will be accepted by experts in the field of standards as falling within their definitions. These are, to be sure, arbitrary standards—in the sense that they are not derived with mathematical precision or by scientific method. But standards they are none the less, for they provide clear definitions and specifications of workers' rights in place of haphazard determinations by management, and they add to this the consensus of agreement which gives them validity. Furthermore, they accomplish a considerable degree of uniformity, which I take to be one of the purposes of establishing standards. They provide a uniform code of rules to govern within a given plant, often extend this uniformity to all plants of a corporation, and to an increasing extent provide uniformity for labor-management relations throughout whole industries.

Agreement of the parties concerned (labor and management) is, as I have stated, the element that gives validity to these standards. On the question of production standards—the amount of work to be performed to earn the specified wage—we are often challenged by those who say they have discovered a "scientific" basis for determining the "right" work content of a given job. By this they mean that the human being can be rated in terms of speed, horsepower, and durability like a machine, and that the amount of work he should do can be determined objectively by time studies of workers on the job.

This we deny. There are numerous time and motion systems in use. How far they fall short of a scientific objectivity is evidenced by the lack of uniformity among them in the results arrived at. Subjective valuations are elements of all of them. They are subject to bias in either direction. They are, in short, elaborate methods of arriving at opinions as to what the work content of a job should be. That being the case, the worker's opinion deserves equal consideration with that of the time study expert. Management opinion is concerned only with the worker on the job. The worker's opinion will be governed also by his fitness to enjoy leisure hours and his desire not to be prematurely aged and burnt out by the requirements of the job. After all the time-study data are collected, whether by management or the union, the only reasonable and workable test of a production standard is mutual acceptability—what both sides are willing to live with. Arrived at and revised empirically through negotiations, this can serve the purposes of a standard as fully as any that is compounded of technically questionable measurements and evaluations of time and motion. The possible lack of uniformity in such a standard from job to job or from plant to plant is compensated by the fact that it is rooted in agreement and meets the test of acceptability.

CIO and AFL participated in the ASA conference of January 23, 1953, called to explore the possibility of establishing national standards in the field of predetermined motion time systems. For the reasons noted above they opposed that proposal and joined in the 16-to-1 vote by which the conference decided not to recommend an ASA project in this field.

Beyond the range of collective bargaining, other standards, or the lack of them, affect the rights and welfare of workers in important ways. State Workmen's Compensation laws define the amounts due to the injured worker or his survivors. State Unemployment Compensation laws define how much and for how long and under what conditions he shall receive income from the state insurance fund when he is laid off. The federal Fair Labor Standards Act directly protects the unorganized worker, and tends to limit the competitive pressure against employers operating under union contracts, by prescribing minimum pay and maximum work hours at straight-time pay for all covered workers.

Standards established under these laws fall far short of collective bargaining standards. The protection they afford is grossly inadequate, both from the workers' point of view and with respect to the broad social purpose these laws were originally intended to serve. Standards of workmen's compensation and unemployment compensation having been left to the states, they have been beaten down by employer lobbies seeking to reduce insurance premiums and the payroll tax, and have been perverted by the states to a competitive means of attracting or holding industry. Consequently the better states are held back by states with traditionally low labor standards. Raising of the federal minimum pay standard to a level that would serve a good purpose in the better states has been delayed by the votes of states that still look upon low wages as a basis of prosperity.

At the beginning of unemployment compensation in 1936-37 the general standard reflected in state laws was that unemployed workers would receive at least 50 per cent of their normal wage, and some went as high as 66⅔ per cent. Maximum weekly benefits were prescribed, however, for the purpose of limiting benefits to the highest paid workers.

This 50 per cent standard has long since been abandoned as a working principle. It can still be found in the benefit formulas of state laws, but failure of the states to raise the maximum limit as wages increased has made the formula inoperative for most unemployed workers. In sixteen states more than 70 per cent of claimants are at the maximum benefit, meaning that almost all of these would get more than the maximum if their benefits were 50 per cent of their normal wages. In thirteen states, 60 to 70 per cent of claimants get the maximum benefit, and in another fourteen states more than 40 per cent get it.

To make the 50 per cent standard effective for most workers, the maximum must be set well above 50 per cent of average going wages in the state so that workers with above-average wages can reach the 50 per cent standard. Most state laws initially provided for this. But with the passage of time, the pressure of employers for a lower payroll tax, and the competitive use of unemployment compensation laws as "business-getting" devices among rival states, maximum benefits increased much less than wages. The following table illustrates this corrosion of the unemployment benefit standard in a period of fourteen years.

Maximum unemployment benefit[a] as a percentage of average weekly wages	Number of states 1939	 1953
20 to 39	–	19
40 to 49	2	29
50 to 69	33	3
70 and over	16	–

[a] Excludes dependents' allowances.

Thus the original unemployment compensation standard of 50 per cent of normal wage has been abandoned. In its place we have as many systerms as jurisdictions, with benefits that are shockingly inadequate to provide decent subsistence to unemployed workers and their families or to supplement national purchasing power sufficiently to arrest the spread of the contagion of unemployment.

Uniformity of this standard has been destroyed by failure of state legislatures, under employer pressure, to adjust benefits to the change in wage levels. In 1939 the maximum weekly benefit was $15 in forty states, $16 in four, and $18 in four. This was approximately uniform. Today it ranges from $20 to $50 a week, and from 30 per cent to 62 per cent of a state's average weekly wage. The maximum number of weeks for which benefits can be paid ranges from 16 to 26½.

As if this wide spread in amount and duration of benefits were not bad enough, state laws also confront workers with a wide variety of eligibility and disqualification provisions enacted for the most part under pressure from employers seeking to emasculate or destroy the social purpose of unemployment compensation while permitting a bedraggled pretense of protection to remain on the statute books.

Labor is determined to re-establish effective standards in this field. It has urged and will urge state legislatures to fulfill the hope stated by President Eisenhower that unemployment compensation can be improved by state action. It will continue to press, however, for federal standards on the amount and duration of benefits in the belief that a fair and nondiscriminatory treatment of the unemployed can best be assured through an act of Congress which takes this vitally human and socially important matter out of the competition of exacting employers exerting their bargaining power on the legislatures of job-hungry states.

The American Standards Association has recommended minimum standards for reporting and tabulating industrial accidents, but these standards are not being maintained or enforced. Forty-seven states require employers to make a report to a designated governmental agency when employees suffer on-the-job disabilities. The legislative history of these measures shows unmistakably that accident reporting was originally intended to indicate unsafe working conditions and to point toward corrective action. However, the collection and tabulation of reports have become routinized; the original aim of reporting has been increasingly neglected and in some cases needlessly abandoned. Accident reporting today lags behind our progress in safety engineering. Despite the long-term downward trend in injury rates, the level of avoidable accidents remains far too high.

A vigorous revival of interest and further development of standards for reporting accidents is needed. Reports of work injuries should be required of all employers and employments, including small establishments which today tend to be proportionately less safe, and employments now regarded as nonhazardous. Reports should be required of all injuries and diseases resulting in death, permanent impairment, temporary total disability beyond the day or shift or necessitating medical care beyond first aid.

Experience has shown the fallacy of believing that industrial safety can be assumed to exist in industries or occupations that fall into the broad classification of nonhazardous. When related to actual exposure, situations in which a few deaths or injuries occur may reveal extraordinarily poor safety conditions. Individual occupations that are decidedly dangerous tend to be lost within the broad classification of nonhazardous industries. The automobile industry itself is often regarded as relatively safe in view of its over-all frequency rate of about six injuries per million man-hours worked. Yet, such activities as lead operations, foundry, forging, and press work are decidedly hazardous.

Despite the great growth in tabulating techniques which make complete reporting analysis more feasible than ever before, there has been a retreat from more complete reporting and more thorough processing of reports.

As for accident benefits, not even a pretense of standards has penetrated state laws on workmen's compensation. Here there is truly shocking revelation of the low value put upon the lives, bodies, and limbs of the victims of industrial accidents by state legislatures, aided of course by the powerful employers' lobbies which never sleep day or night in their zeal to keep compensation benefits low.

A worker's life is worth a maximum of $13,500 under the compensation law of Oklahoma. In South Dakota it may be worth as little as $5000 "or four times the average annual earnings whichever is less." An arm off at the shoulder is worth $18,500 to the accident victim in Wisconsin. In Michigan it is valued at $11,298, in Texas at $5000 and in Alabama at $4600. A leg has the same compensable value as an arm in Wisconsin, but in Michigan it is worth $2000 less than an arm and in Alabama $575 less. Maximum compensation for loss of an eye is $10,175 in Wisconsin, $6804 in Michigan, $5320 in Illinois, $2500 in Texas, and $2300 in Alabama. Blindness in one eye brings as little as $1650 in Arizona as the maximum benefit, $2300 in Alabama, $2400 in Rhode Island, and so on up to $19,350 under the Federal Employees' Compensation Act.

Whether, under an economy that is national in its operation, it will ever be possible without federal action to develop a uniform national approach to workmen's compensation is questionable. The CIO has proposed a national workmen's compensation law that would strengthen the reporting requirements and provide uniform and adequate benefits. At the least, federal standards are needed to which state compensation laws should have to conform.

Urging approval of a Federal Industrial Safety Act by the Senate Labor and Public Welfare Committee in 1952, the UAW-CIO Legislative Representative said:

> Industrial health and safety are proper subjects for federal legislation for the same reason that labor-management relations are a proper subject for federal legislation. Gresham's law that base money tends to drive out good money applies pretty much throughout our economy and our society. As in coinage, which is a power of Congress, so throughout our economy and in our society base standards tend to drive out good standards; good and improving standards uniformly applied without discrimination between or among states, industries, plants, or individuals, tend to bring about wider and better observance of such higher standards.
>
> In industrial health and safety, as in wages and hours, in the prohibition of child labor, in unemployment insurance, in old age and survivors' insurance, we can have the vicious descending spiral of sweatshop and cutthroat competition at the expense of workers and, indirectly but nonetheless surely, at the expense of the health, strength, and security of the nation as a whole. Or we can have the beneficent ascending spiral of better and wider industrial health and safety made possible by taking human health, bodies, and lives out of interstate competition.

But Congress has not set uniform standards; compensation for workers' injuries conforms to no reasonable standards—economic or human.

Standards for consumer goods could benefit union members equally with other consumers, but we have seen little development along this line. I would emphasize here that I am not suggesting that consumer goods be standardized—all made to a single pattern. There are many industrial applications of standards where simplification and standardization of sizes and varieties can accomplish real economies. I doubt, however, that we American consumers, accustomed as we are to a wide range of choice and a steady flow of innovations (for better or worse), would welcome any attempt to force the products we buy into uniform molds.

But suitable consumer standards could, I believe, greatly enhance the valued right of the consumer to make a choice. These would be standards of quality, or more specifically, standards of construction or performance, used to describe the goods we find in stores. An almost endless assortment of descriptive terms confronts us, supposedly to tell us something about what to expect of the things we spend our money for. Actually this descriptive jargon seldom provides any solid information to the average consumer. Only the expert understands it, and being an expert he does not need to be told. Most of us just misunderstand, and that, I suspect, is exactly what we are supposed to do, doubtless on the theory that a flattered, bewitched, and mystified consumer parts with his money more cheerfully than one who bothers himself with too many questions.

I doubt that many consumers will become precision buyers, checking and comparing detailed specifications, even if such information were made available. But the development of standards by which the relative performance, durability, economy of use, ease of repair, or other suitable bench marks could be shown on labels would be of great value to all of us in spending our money. Only the makers of honest merchandise, I suppose, would care to show these standard values on the label, including not only the highest quality goods but also those that are good at the price charged. This in itself would give the consumer something to go by.

The real contribution of such a system of merchandising would come about by tending to eliminate from the market the two basic types of frauds that are foisted on us today. I refer, on the one hand, to the worthless, bargain-rate type of commodity that is a bad buy at almost any price, and, on the other, to the great family of super-advertised, over-priced, snob-appeal goods that coax us to expend a dollar and a half on the prestige of a famous name for every dollar we spend for usable quality.

This, I suggest, is a fertile field for the standards profession to explore. But I am not hopeful. Much of the advertising business today is engaged in selling prestige at a premium, and the advertising business is big business. It is well organized; consumers almost not at all. Until someone discovers a way to organize consumers either to vote as consumers or to engage in collective bargaining on a large scale with the makers and merchants of consumer goods—but that is another subject.

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28. CONSUMERS' STAKE IN NATIONAL STANDARDS

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CONSUMERS are concerned with almost all aspects of national standards discussed in this volume since most of our economic efforts today revolve around growing, making, and distributing consumers' goods in one form or another. Many of the so-called "military" goods are really consumers' goods.

The American people have a real stake in the use of national standards in both the manufacture and the distribution of the goods they buy and use. Standards in the manufacturing process are important to consumers because they affect the kinds and quantities of goods which are available for purchase, as well as the costs and characteristics of goods which come on the market. Standards also play a significant role in the distribution of goods because they determine to a considerable degree the extent to which consumers are able to be efficient buyers of these goods.

CONSUMERS' GOODS STANDARDS IN MANUFACTURE

The use of standards in manufacture makes the mass production of goods possible. Standards provide for the uniformity of raw materials, the standardized designs, equipment, processes, and conditions required by machines to produce large quantities of goods. Furthermore, standards make possible the relative uniformity of each machine-produced unit; they lead to the improvement of quality and performance of consumers' goods; and they tend to reduce production errors. Standardized tests and inspection procedures for finished products result in the elimination of those units which do not meet desired levels of quality. Costs of goods are also reduced when standards are used in manufacturing: the machine process decreases the cost per unit by turning out many units, and the application of standards brings down the cost by reducing wastes—wastes in raw materials and labor and wastes from the production of defective or nonacceptable units.

In all probability very few consumers realize the extent to which they are indebted to the use of standards in the manufacturing process. Although these benefits are great, it must be realized that maximum benefits have not, as yet, been fully realized. Standards are not universally used in making goods. Many individual producers do not realize the importance and value of standards in operating their businesses. Many industries have taken no steps, or only rather feeble ones, to coordinate their work and adopt industry-wide standards. National and international standards have been developed in some areas but few are extensively used today.

Consumers' Goods Standards in Distribution

NEED FOR STANDARDS

Although consumers' stake in standards in industry looms large, their stake in standards in marketing is equally as large and possibly larger. Consumers must be able to buy efficiently the goods which are available in the markets. Until this is an accomplished fact they cannot derive the maximum benefits from industrial progress. Standards as used today in industry and commerce do not answer the questions of over-the-counter buyers regarding the use value of the commodities offered to them and the relation of this value to the prices asked.

To buy efficiently consumers must be able to identify the particular goods which possess the characteristics they want. They must be able to compare the characteristics of products offered at different prices, in different stores, and at different times. This is difficult, if not impossible, in buying most consumers' goods today. The difficulty stems in part from the character of the goods on the market, in part from the characteristics of consumers, and in part from the practices of makers and distributors.

The abundance of merchandise of confusing similarity, the multiplicity of brands, and the many new and complex goods on the market make selection difficult for consumers who are not well prepared to cope with the situation. They buy in small quantities. They buy many different kinds of products. They have many other duties besides buying, and the time they have to spend in buying may be short. Many consumers have had little or no training as buyers and are unaware of or uninterested in the problems they face. Some of their buying is impulsive or irrational. Some of it is for prestige rather than for utilitarian values. Makers and distributors often employ high-pressure selling tactics. They fail to use such facts as are available in advertising and on the labels of goods. All too often unimportant characteristics are emphasized, scientific facts are juggled, and only half-truths are revealed.

There is no single solution to this complex situation faced by consumer-buyers. Rather it must be attacked on all fronts. Standards which describe consumers' goods do provide, however, an important means of solving the situation. Standards are actually measuring sticks: they are used for measuring quantities of goods as well as for describing and measuring their qualities and performances.

When consumers' goods are described in terms of generally recognized and widely used standards, buyers are able to identify and compare goods as they find them on the market. When consumers are able to do this, their satisfactions with their purchases are increased. Their mistakes in buying are reduced and their chances of getting products which really fit their needs are greatly improved. This is especially true when information about goods is provided in terms of their performance in use. Standards make it possible for consumers to save money as well as time and effort in buying. Moreover, standards make it possible to educate consumers regarding important qualities of goods by providing the only satisfactory means of recognizing most of these qualities.

Only relatively small beginnings have been made to date in the use of standards to describe consumers' goods in the retail market. Standards are used only infrequently in advertising and on labels to describe qualities and performances of commodities. Few national standards have been set up and fewer are in general use. Standards are not even used as extensively or as satisfactorily as they might be in describing quantities of consumers' goods.

WHERE STANDARDS ARE USED

Food

In the case of foods, most, although not all, of the standards used in the enforcement of the Food, Drug, and Cosmetic Act are minimum standards. If foods fall below these standards they are taken off the market. Such standards protect consumers from inferior foods but they do not assist them in selecting foods from among those which are on the market. Standards of quality providing for two grades are required for a few canned foods, although products so labeled are seldom found on the market since those not meeting the standards are sold unlabeled in intrastate commerce.

The United States Department of Agriculture has established voluntary standards for grading many agricultural products. Some of these are for products used by consumers. However, only a small portion of the total of such products sold throughout the country is labeled to indicate grades. The products on which such labels are most frequently found include meat, poultry, eggs, butter, cheese, canned fruits and vegetables. Although some of the standards for these products are called "consumer standards" and the resulting grades "consumer grades," it is doubtful that the terms are proper in all cases. Most of these standards were developed for use in large-scale buying and selling and there is little, if any, assurance that they are based on qualities important to consumers. They are based rather on qualities which buyers and sellers in wholesale markets have found to be important in their transactions.

Some states require a few food products to be labeled according to grades based upon one or more standards. In order to meet the requirements of the Food, Drug, and Cosmetic Act, labels of some food products carry a list of ingredients. Infant foods and pet foods are among the few of the labels which give ingredients in terms of percentages.

Clothing and Textiles

Even fewer standards are used in describing clothing and household textiles. Most of those used are definitions for such products as wool, rayon, furs, and for such finishes as waterproof, mothproof, and the like. Although performance in use is very important in clothing and household textiles, few standards have been established. Those which have been set up but which are seldom used in describing consumers' goods in the market include colorfastness, shrinkage, tensile strength, flammability, and a few others. Specifications regarding construction of fabrics such as ply of yarn, number of threads in an inch, weave, and weight in ounces, are available but are not widely used.

Fibers used in textiles and clothing are usually given on labels only when required by specific laws such as the Wool Labeling Act. Some states require the labeling of bedding and upholstered furniture with composition of materials. Efforts have been made to set up national standards for sizes of garments, but on the whole they have not been successful. In the case of children's clothing, for example, the established standards have not been widely adopted. National standard specifications for sheets and pillowcases have been established but are not generally used in labeling and advertising these products.

Household Equipment

Kind of wood used in furniture is given on labels only in rare instances. Bed sizes have been standardized. Grades have been set up for mirrors, although one seldom finds mirrors labeled according to these grades. The most widely used standards applicable to household equipment are the minimum standards of approval which have been set up by the American Gas Association and the Underwriters' Laboratories. A great many products concerned are labeled with the identification or approval seals of these agencies. As in the case of the minimum standards of the United States Food and Drug Administration these approval seals do not assist buyers in choosing among the products which carry these seals. Grades on lumber and similar materials are sometimes useful to consumers.

Drugs and Pharmaceuticals

The Food, Drug, and Cosmetic Act provides for minimum standards for drugs and pharmaceutical products. As in the case of foods, these requirements keep the inferior products off the market but do not provide consumers with guides for buying drugs and related items which meet or exceed the minimum standards. The U. S. Food and Drug Administration supervises the labeling of vitamins and similar preparations to protect the public from unwarranted claims, and today most of these products are labeled to show their composition in terms of standard units.

The foregoing brief resume of the use of standards to describe consumers' goods today is not intended to be inclusive but it serves to point out that the application of such standards on a national scale is limited.

Causes of Limited Use of Consumers' Goods Standards

Efforts have been made from time to time to set up national standards for various kinds of consumers' goods. Efforts have also been made to secure the widespread use on labels of such national standards as have been set up. Except for those enforced by federal law, relatively few such standards are in existence today. The question must inevitably be asked: why is the use of standards for consumers' goods so limited today when that of standards at other points in the marketing process has proved so valuable? Another question also occurs: are there any prospects in the future for the widespread use of standards for describing consumers' goods?

A number of problems create obstacles, real and fancied, to the establishment of standards programs. The problems arise in part from the character of the activities involved in standardization work, in part from consumers and the characteristics of consumers' goods, and in part from the resistance of producers.

P. G. Agnew pointed out that standardization work involves two groups of quite different activities: first, the laboratory work or the research and technical study to secure the necessary facts upon which standards must be based, and second, the necessary agreements by all concerned regarding the kinds and character of standards to be used and the decisions as to how the standards are to be put into use.

National standards for consumers' goods have in the past failed to overcome the obstacles arising in one or both of these groups of actitivies. Sometimes standards have been attempted before adequate information was available. Often they have failed because agreements could not be reached among those concerned as to the kind, character, and use of standards. Even when national standards have been set up, their use in labeling has been very limited. The twenty-year struggle to establish national standards for bed sheets illustrates these problems.

Certain groups representing consumers became interested in standards describing bed sheets, and the first conference to consider the development of nationally recognized specifications was called in 1927. It was not until 1948 that the American Standard Specifications for sheets and sheeting were approved by the American Standards Association. The delay was not caused by the lack of technical information but by the failure of certain groups to cooperate and by the inability of the different groups to come to an agreement regarding the standards. As illustrated by this case, too often there has been a lack of cooperation and coordination required in a program of national standards for consumers' goods.

ATTITUDES OF CONSUMERS

The position of consumers in the economy, the lack of intelligent freedom of choice, their inability—either individually or in groups—to exert pressure where and when pressure is needed, are in part responsible for the current inadequacy of national standards for consumers' goods. Consumers have not assumed as dominant a role as they might. They have not generally demanded standards, not because of a positive desire not to have them, but because of a lack of knowledge of standards. They have not known as much about standards as they should and have not appreciated the benefits to be derived from them. Moreover, consumers have in some cases become confused about the desirability of standards, especially those establishing grades, because they have been told frequently by some sellers that present guides are entirely satisfactory for efficient buying.

A further hindrance to the establishment of standards has been the fact that the consumers have not been generally articulate about their wants. They have had little opportunity to learn to express their likes and dislikes except through dollar votes. Some not only have not expressed their wants but have not been clear in their own minds as to what they want.

CHARACTERISTICS OF CONSUMERS' GOODS

The characteristics of consumers' goods have also made the use of standards difficult. Consumers' goods are bundles of utilities and many are used for widely different purposes and under many different conditions. Consumers have such varying tastes and incomes that it is sometimes difficult to determine the relative importance of the characteristics of some goods. Psychological values enter into many of the purchases further to complicate the problem. Not enough has been known about many goods for the establishment of sound standards.

PROCEDURES AND AGENCIES

One of the obstacles to progress has been the absence of well-defined procedures for setting up standards for consumers' goods and for extending them into use. Furthermore, the absence of agencies to assume the responsibility of establishing standards, and to certify and check conformance of goods in the market to existing standards, has constituted a barrier to progress. There are few agencies interested in developing standards for consumers' goods which are not dominated by interests other than those of consumers. On the other hand, there are only a few groups which are interested in or qualified to represent consumers in setting up national standards.

ATTITUDES OF MANUFACTURERS AND DISTRIBUTORS

Producers and sellers as a group have not supported the programs of standards and informative labeling for consumers' goods. They have not supported them either through financial contributions or through their interest and personal efforts. While a few producers and merchants have actively demonstrated their interest, others have definitely opposed the programs as undesirable. Most of them have been simply indifferent. The failure of manufacturers and distributors in general to concern themselves with promoting standards for consumers' goods cannot be explained as due to resistance to the standards technique itself, since they use it in their own dealings with one another. Most of them would agree that it would be impossible to make goods or to carry on trade under existing conditions without standards. It must be concluded, therefore, that it is only the application of standards to consumers' goods which they have opposed or to which they have been indifferent.

Some alert producers and sellers have supported the program in its entirety, carrying it into practice by taking part in the development and establishment of national standards and by using standards to describe their goods. Some have supported part of the program for national standards but have not gone so far as to provide consumers with definite facts about qualities and performances of goods in terms of national standards. Others have approved labeling to show that goods meet minimum specifications, but they have not given information to enable consumers to compare qualities and performances of goods which are above these minimum specifications.

Some producers and sellers have supported the program in principle but have done nothing about it. Some have believed, no doubt sincerely, that consumers do not want standards and informative labels, and would not use them if they had them, while others have maintained that consumers do not need any more information than they already have. A few manufacturers and sellers have objected to the standards program because they are selling goods at higher prices than the quality warrants. Fear of the untried and unknown has caused some producers and retailers to oppose the use of standards for consumers' goods. They have not wished to embark upon a program which has seemed to them to hold so many uncertainties.

The reaction of producers and distributors to the establishment and use of standards for consumers' goods has varied with their interests and activities. In general large-scale manufacturers who have spent much money and effort to build up goodwill and prestige for their brands have been indifferent to or have opposed the program. Advertising agencies, magazines, and newspapers which depend upon advertising have generally followed the lead of the large manufacturers who advertise extensively. On the other hand, distributors, particularly large-scale retailers, have shown much more interest in standards than have some groups of producers. In some cases these retailers, including several large department stores and mail-order firms, have taken an active part in the promotion of the standards program.

Consumers' Goods Standards in the Future

Standards for consumers' goods require the support of all, each contributing in proportion to his capacity in both knowledge and funds. Individuals and groups, consumers and producers, must work together. Eventually the full cooperation of consumers, manufacturers, growers, wholesalers, retailers, and others concerned with making and marketing of consumers' goods will be required in a full-scale program. However, the present lack of such complete cooperation among all groups does not constitute an unsurmountable obstacle to the program. As producers join the leaders among them now taking an active interest in standards for consumers' goods, and as consumers learn to take an articulate and active interest in standards, this and other obstacles will largely disappear and the way will be paved for a widespread and full-scale program of benefit to all.

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29. CONSUMER GOODS STANDARDS AND THE SHERMAN ACT

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WHETHER and, if so, in what circumstances the deliberate adoption of standard specifications for consumers' products[1] may run afoul the federal anti-trust laws are not questions which can be answered categorically. The answers do not fall—as, in fact, little within the anti-trust field falls—within the *quod ab omnibus, quod semper, quod ubique creditum est* category.

The provisions of the Sherman Act are familiar. Its section 1 declares to be unlawful "every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several States. . . ."[2] For sixty-five years the courts have been busily engaged in construing this epitome of the cryptic. And for some hundreds of years before its enactment the courts had been engaged, in their common-law way, in writing its background. But for all this and for all of the study that has been given to the legislative history of the Act and the public clamor that gave rise to its enactment, it is doubtful whether any lawyer can give his clients the kind of unequivocal assurance they like to have that a proposed course of conduct in agreeing upon, adhering to, and perhaps enforcing common standards in the field of consumer goods is beyond reproach.

It would be well, before looking at the few cases in which standardization was specifically made an issue (for assurance can be given that they will turn out to be highly unsatisfactory in answering the questions that have been posed above), to remind ourselves of a few of the generalized statements in which the Supreme Court has summarized the Sherman Act for itself.

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[1] It is probable that I shall be found guilty, throughout this discussion, of missing many of the nuances that have developed in the use of the term "standardization." As the text will indicate, I have not attempted to differentiate between standardization, simplification, and the like. The differences are, as far as one can judge in the abstract, not likely to be persuasive of different results under the Sherman Act.

[2] Act of July 2, 1890, 26 Stat. 209, 15 U.S.C., sec. 1.

The Act went through a twenty-one-year period of gestation before there finally emerged, in one of the most tortuously written opinions on the books, Mr. Chief Justice White's "rule of reason." The opinion furnishes little of quotable quality, but its substance can perhaps be gleaned from the stated conclusions that the Sherman Act evidences "the intent not to restrain the right to make and enforce contracts, whether resulting from combination or otherwise, which [do] not unduly restrain interstate or foreign commerce, but to protect that commerce from being restrained by methods, whether old or new, which would constitute an interference that is an undue restraint" and that "the criteria to be resorted to in any given case for the purpose of ascertaining whether violations . . . have been committed, is the rule of reason guided by the established law and by the plain duty to enforce the prohibitions of the act and thus the public policy which its restrictions were obviously enacted to subserve."[3]

The cases that have been decided since 1911 play many variations on this theme. The statement has become somewhat less cumbersome as different justices have rephrased it and it has, perhaps, gained in clarity as it has been applied to particular circumstances too varied to spell out in this short space. But it still leaves, and can never avoid leaving, a large margin of uncertainty. Three such rephrasings will suffice to illustrate the point. The first is from an opinion written by Mr. Justice Clarke:

> It has been repeatedly held by this court that the purpose of the statute is to maintain free competition in interstate commerce and that any concerted action by any combination of men or corporations to cause, or which in fact does cause, direct and undue restraint of competition in such commerce falls within the condemnation of the act and is unlawful.[4]

The second is Mr. Justice Brandeis's summary:

> But the legality of an agreement or regulation cannot be determined by so simple a test, as whether it restrains competition. Every agreement concerning trade, every regulation of trade, restrains. To bind, to restrain, is of their very essence. The true test of legality is whether the restraint imposed is such as merely regulates and perhaps thereby promotes competition or whether it is such as may suppress or even destroy competition.[5]

And the third is from Mr. Chief Justice Hughes:

> The restrictions imposed by the Sherman Act are not mechanical or artificial. We have repeatedly said that they set up the essential standard of reasonableness. . . . They are aimed at contracts and combinations which "by reason of intent or the inherent nature of the contemplated acts, prejudice the public interests by unduly restraining competition or by unduly obstructing the course of trade." . . . Designed to frustrate unreasonable restraints, they do

[3] *Standard Oil Co. of New Jersey* v. *U.S.*, 221 U.S. 1, 60, 62 (1911).

[4] *American Column and Lumber Co.* v. *U.S.*, 257 U.S. 377, 400 (1921).

[5] *Chicago Board of Trade* v. *U.S.*, 246 U.S. 231, 238 (1918).

> not prevent the adoption of reasonable means to protect interstate commerce from destructive or injurious practices and to promote competition upon a sound basis.[6]

Such quotations could be multiplied many times. All of them leave open to argument in the light of particular experiences the answers to the questions, What is "undue"? What is "unreasonable"? What "merely regulates"? What "suppresses"? What are "destructive or injurious practices"? What "promotes competition upon a sound basis"? What "prejudices the public interest"? Certainly they give us no settled answer—and there has not been occasion for a settled answer—with respect to the application of the Sherman Act in terms of the questions with which we are here dealing.[7] Let us, then, turn to the cases in which these questions have played some direct part.

In *Milk and Ice Cream Can Institute* v. *Federal Trade Commission*,[8] it was alleged that the members of the Institute

> had maintained an unlawful combination to restrain competition in the manufacture, sale and distribution of milk and ice cream cans in interstate commerce; that they had "cooperatively made and announced prices" in such a manner that the delivered cost of their products to a purchaser was the same regardless of the producing point; . . . *and that they had standardized and promoted uniformity in their products for the purpose of lessening competition.* (Emphasis added.)

The gravamen of this complaint was, of course, the charge of price fixing. As the reviewing court said, "the essential question . . . is whether the members of the Institute acted in combination or by agreement for the purpose of fixing prices, or their activities contributed to such result as found by the Commission." It is unnecessary here to repeat or to outline the court's discussion of the bulk of the case. Suffice it to quote that portion of its opinion which deals with the problem which concerns us:

> Much is said by petitioners concerning their claim that milk and ice cream cans are a standardized product. From this it is argued that uniformity of price was a natural rather than an artificial result. An argument of this kind has some merit as to certain products, such as sugar, salt, oil, etc., where the product from its nature is standard.[9] We doubt, however, if there is any

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[6] *Sugar Institute, Inc.* v. *U.S.*, 297 U.S., 553, 597 (1936).

[7] It is worth noting that in some cases the Court has specifically mentioned the absence of any questioning of defendants' standardization activities. See, for instance, *Maple Flooring Manufacturers Association* v. *U.S.*, 268 U.S. 563, 566 (1925): "The defendants have engaged in many activities to which no exception is taken by the Government and which are admittedly beneficial to the industry and to consumers; such as . . . the standardization and improvement of the product."

[8] 152 Fed. (2d) 478 (C. C. A., 7th, 1946).

[9] If a layman may do so, I would like to express the doubt whether any of these products is, "from its nature," standard. Are there not all degrees of (to use my lay language) sugariness, saltiness, and oiliness? And is not grading one species of standardization?

> merit in the contention that a can is in such a category. We think it is true that they were standardized in the instant situation, but this was the result of the activities of the Institute and its members. In fact, there was a continuing effort and urging on their part that the cans be manufactured in uniform classifications. It may be, as argued, that most of this effort was to comply with various governmental regulations and for health purposes, but the fact still remains that it was easier to reach the goal of uniform prices on a standard product than on one which was not. The meticulous effort disclosed by the record by which petitioners standardized their products is also a strong circumstance in support of the Commission's finding that their activities were the result of an agreement.

It should be noted that, notwithstanding this discussion, neither the cease and desist order of the Commission nor the court's injunction prohibited continuation of the Institute's standardization activities.

In *Fort Howard Paper Company* v. *Federal Trade Commission*,[10] the gist of the complaint was also price fixing, this time in the crepe-paper field. The Commission, among other things, ordered the respondents to cease and desist from "Adopting or maintaining uniform standards governing creping ratios, sizes, or weights of crepe paper, or the sale of seconds or close-outs, . . . [to maintain] uniform prices for crepe paper." The court affirmed. It noted but was apparently not impressed by the position of the petitioners:

> There was a consensus of opinion among the petitioners that crepe paper is a standard product—no one could obtain a greater price for it than another inasmuch as quality does not vary. All use similar tissue paper, which is "creped" or crinkled on similar creping machines so that the resultant product is identical irrespective of the manufacturer. The industry has found that the "creping ratio"—which means the ratio of the length of the paper before, and after, creping—should vary according to the use for which it is to be put—draping crepe requires a denser creping ratio than flooring crepe, and that the NRA [National Recovery Administration] served to standardize the resultant product, as to permissible length of crepe paper in a packet, etc.

So, also, in *Bond Crown & Cork Company* v. *Federal Trade Commission*,[11] where there was found to be a concerted course of action among manufacturers who controlled 85 per cent of the business of making crown bottle caps. The Commission found that, upon organization of the Crown Manufacturers Association of America, "One of the first things that it did was to bring about more complete standardization of the product in that, by agreement of the manufacturers, the decoration of the caps was made uniform, so that those sold by all manufacturers were identically the same." And the court pointed out that "The product has been so standardized that there is no choice of any sort between the products of different producers, and a purchaser anywhere in the country can purchase at the same price including freight from any producer." It was found that there was a "direct connection" between the respondents' understanding with respect to prices, discounts, and terms of sale on the one hand, and on the other "the admitted efforts of the respondents to standardize their products to such an extent that a prospective purchaser would have no choice in the realm of coloring, lettering, the decorations as between the products of any two manufacturers. . . ."

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[10] 156 Fed. (2d) 899 (C. C. A., 7th, 1946), *cert. den.* 329 U.S. 795 (1946).

[11] 176 Fed. (2d) 974 (C. A., 4th, 1949).

The defendants' efforts to persuade the court that, each of their practices complained of being innocent by itself, the Commission's order should not be enforced were fruitless:

> Innocent explanations are offered as to each of the circumstances relied on by the commission, and if it were permissible to consider each of the circumstances out of connection with the others, there would be much force in the argument of the petitioners. When all of the circumstances are considered together, as they must be, however, there can be no question as to their sufficiency to support the findings and conclusions of the commission. The standardization of product, for example, would be innocent enough by itself, but not when taken in connection with standardization of discounts and differentials, publication of prices with agreements not to charge less than a minimum under patent license agreements affecting practically the entire industry, the freight equalization which we have described and such uniformity of prices throughout the industry as to leave no price competition of any sort anywhere.

Finally, we have *C-O-Two Fire Equipment Company* v. *United States,*[12] a criminal prosecution under the Sherman Act. As in the preceding cases, the gist of the government's complaint was price fixing. And as in them standardization was a secondary point. The government pointed to it "as another plus factor in the chain of circumstances that points to the conspiracy alleged." The situation, as seen by the court, is set out in its opinion thus:

> It is the contention of appellants that this standardization and substantial identity of product serves to explain the admitted price uniformity in the industry during the pertinent period. We think, however, that such standardization of a product that is not naturally standardized facilitates the maintenance of price uniformity. . . . The appellants seek to rebut such conclusion and any inference of combined action that may arise therefrom with the testimony of their witness, Allen, that "we are required to meet standards set up by the Underwriters Laboratories in this respect, that we are required to put out certain sizes in order to obtain certain ratings . . ." This evidence may well explain the artificial standardization in regard to size. But we can well

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[12] 197 Fed. (2d) 489 (C. A., 9th, 1952), *cert. den.* 344 U.S. 892 (1952).

> understand why the trial judge was unable to accept Mr. Allen's testimony as a satisfactory explanation for the similarity in color and other physical characteristics among the extinguishers manufactured by the different defendants. Appellants make no effort to explain why these products, although manufactured by different companies, and formed of components manufactured by different companies, were indistinguishable save for their respective labels.

The moral of these four decisions is clear enough—that attempts on the part of all or a substantial portion of an industry to standardize or simplify are likely to run afoul of the law when they are part and parcel of what is found to be a price-fixing agreement. Indeed, the Supreme Court has made it clear that the very existence of standardized products in a given field makes more important than otherwise the maintenance of other forms of competition:

> Another outstanding fact is that defendants' product is a thoroughly standardized commodity. In their competition, price, rather than brand, is generally the vital consideration. . . . The fact that, because sugar is a standardized commodity, there is a strong tendency to uniformity of price, makes it the more important that such opportunities as may exist for fair competition should not be impaired.[13]

But this, of course, does not carry us far in answering the broader question that was asked at the beginning of this essay. To answer it we have little, if anything, to rely on except our knowledge of the general purposes of the Sherman Act and an assessment, in each particular case, of the effects and merits of the adoption of standardization on the market, on competitors, and on consumers. We must not be misled by the fact that the great bulk of the cases under the Sherman Act has centered around a limited number of typical complaints: price fixing, restrictions on production, elimination of competitors, division of territory, and the like. For the Sherman Act's prohibitions, we have been authoritatively told, go far beyond these:

> Petitioners . . . argue that the combination cannot be contrary to the policy of the Sherman and Clayton Acts, since the Federal Trade Commission did not find that the combination fixed or regulated prices, parcelled out or limited production, or brought about a deterioration in quality. But action falling into these three categories does not exhaust the types of conduct banned by the Sherman and Clayton Acts.[14]

Nor can we allow ourselves to be misled by the fact that the Federal Trade Commission tells us that it has found it necessary, in some instances, to impose minimum standards on competitors in the exercise of its authority to prevent unfair methods of competition,[15] for the legality of acts done at the direction of a government agency is far from conclusive in determining the legality of acts done without such direction.

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[13] *Sugar Institute, Inc.* v. *U.S., supra* note 6, at p. 600.

[14] *Fashion Originators' Guild of America* v. *Federal Trade Commission,* 312 U.S. 457, 466 (1941).

Perhaps, then, the best approach to the questions asked is to remind ourselves that the machine age has made inevitable standardized products on the part of most individual manufacturers, that there is a necessity for at least grade standards and standardized nomenclature in the conduct of the great commodity markets of the world, that the same are of growing importance to the individual consumer, and that in those realms where utility is of greater consequence than style or taste, other types of standardization can and do confer many benefits upon the consumer. It is not difficult, looked at from this point of view, to conclude that in most cases the restraints which come with manufacturers' adherence to a set of standards for consumers' goods are prima facie not "undue" or "unreasonable."[16]

But all of these are considerations which weigh heavily only as of a given moment or over a short span of time. We have got also to remind ourselves constantly of the dangers that, looked at over the longer run, the standardized product or process may become an old-fashioned product or process and that its very existence may inhibit advance.[17] We have also to remind ourselves that standards can be set so high that the consumer buys a more costly product of a better grade than he needs or can afford. We have to be sure to bear in mind that the anti-trust laws are for the protection not only of the consumer but of the individual trader and that standards must not be so set and enforced, therefore, as to drive him to the wall.[18] In all of these cases the prohibitions of the anti-trust laws may as readily come into play as they do when standardization becomes, as the cases outlined in some detail above indicate it can become, a means on the part of selfish groups to fix prices.

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[15] See *Control of Unfair Competitive Practices Through Trade Practice Conference Procedure of the Federal Trade Commission,* Temporary National Economic Committee Monograph No. 34 (Washington, D. C.: U. S. Govt. Printing Office, 1941), p. 16.

[16] Judicial notice was taken in *Pacific States Box & Basket Co.* v. *Gehlar,* 9 Fed. Supp. 341, 342 (D. C. D. Ore., 1934), affirmed 296 U.S. 176 (1935), of certain benefits of standardization: "It is a matter of general knowledge that enforced standardization of containers is essential to the economic handling, shipping, and selling of horticultural products, for, among other reasons, it prevents fraud and deception in sales, provides the best method of stowage, and eliminates many sizes that complicate the problems of transportation."

[17] I cannot resist a hypothetical example of what I mean. Consider the irreparable harm that would have resulted if, prior to the advent of the 33⅓ r.p.m. record, all manufacturers had agreed on the 78 as standard and had bound themselves to observe that standard. But consider, on the other hand, the cost to the consumer today if records were produced at speeds varying all the way from say, 15 to 100 r.p.m. I cite this as an illustration of the importance of keeping the time factor in mind, and with that factor in mind, of keeping the way open for constant reappraisal of standards in the light of consumer needs and technical possibilities.

Fifteen years ago when I enjoyed the acquaintance of the man in whose honor this volume is published, the anti-trust problems which have been discussed above were troubling him. The answers were indefinite then. They are indefinite now. But I suggest that as long as standardization and the Sherman Act are both viewed and used as means to the same ends—the ends of keeping a free market, of maintaining an open way for technological advance, of fostering competition—the questions asked at the beginning of this essay will remain as happily academic as, for the most part, they have been to date. If, on the other hand, standardization departs from these norms, either it or the Sherman Act will have to give. It is not likely that it will be the Sherman Act that does so.

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[18] *Cf.* In the Matter of Henry S. Borden, 48 F. T. C. 1499 (1951), holding that the failure of an individual manufacturer to abide by a Commercial Standard promulgated by the Department of Commerce and adhered to by a substantial portion of the industry in his area forms no basis for a charge of engaging in unfair methods of competition.

30. STANDARDS AND PRODUCT DIFFERENTIATION

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THE DIFFERENTIATION of products is one of the techniques developed by businessmen in adapting their activities to the opportunities and pressures they encounter in the market. Three kinds of differentiation may be distinguished. The first is the differentiation of a single company's products, so that what might have been a uniform commodity appears as several brands, grades, or styles, offered for sale simultaneously by the same seller. The second is the differentiation of the same product in successive periods of time, so that there is a clear distinction between the seller's current model and his previous models. The third is the differentiation of one company's product from that of its competitors, so that no competing concern offers an exact equivalent. These three forms of differentiation may appear separately or together.

The Problem

The first type of discrimination, the production of more than one variety of the same product is, in the simplest case, a recognition of the fact that different consumers have different tastes which can be satisfied in different ways. By offering a variety of goods, the seller can cater to each taste more exactly. But where this is all that is attempted by differentiation, the entire range of products will be made available to every buyer and the different characteristics of different products will be clearly identified so that intelligent choices can be made. Thus a food canner who offers a special line of products for diabetics will label his diabetic pack clearly and state specifically the nature of its differences from his ordinary line.

However, a seller may endeavor to create differences in product that are not spontaneously demanded by his customers. He can do this by exaggerating the importance of preferences so small that, but for his commercial exploitation of them, buyers might not be aware such preferences existed or might attribute to them a negligible value. On occasion, he may create product differences where there is no reason to believe that they reflect any differences at all in the tastes of consumers. Such types of differentiation are usually adopted because the seller thinks them useful as a means of discriminating in price between buyers who differ in their ability or willingness to pay.

Although price discrimination is commercially attractive to the seller, it is hard to establish if the seller's product is uniform; for the customers who are asked to pay the higher prices are likely to resent the exaction and to find ways of buying at the lower prices instead. When products are differentiated, the seller has an excuse for the price discrimination which makes the different prices more palatable and more effective. For a supposedly exclusive or luxurious product, he may be able to obtain from the rich, the snobbish, or the careless a price and profit greater than he could persuade the poor and the careful to pay. Moreover, he may be able to classify his customers into groups that differ in the ease with which they could leave him for other sellers, and to charge most where he need fear competitors least. Such price-raising where the traffic will bear it works better if the products offered at different prices are so differentiated that the customers who are expected to pay more cannot easily shift to the cheaper product.[1]

Where price discrimination is the purpose of variation in a seller's products, the nature of the differences between products is not likely to be clearly stated; for the discriminatory purpose might be defeated if buyers understood the differences and attributed appropriate money values thereto. Moreover, the seller may offer one variety of product only to buyers he has placed in one price class, in order to decrease the chance that the buyers who are expected to pay high prices may avoid doing so. Secrecy about the exact nature of product differences and unwillingness to permit buyers to choose freely among the varieties produced are reliable indicators that the seller has a discriminatory purpose.

However the fact that there is a purpose to discriminate cannot safely be taken as proof that the differences in the seller's product are merely artificial or unimportant. Discriminations in price are most solidly based when they rest upon spontaneous differences in the tastes of consumers.

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[1] In a striking instance a plastic was sold to commercial molders in the United States for 85 cents per pound but to manufacturers of false teeth for $45 per pound. When some makers of dentures discovered the availability of the lower-priced commercial molding powder, the sellers sought to prevent what they called "bootlegging" by some form of product differentiation. One expedient which was considered was the introduction of arsenic into the commercial molding powder. See *Economic and Political Aspects of International Cartels,* Monograph No. 1, Subcommittee on War Mobilization, Senate Committee on Military Affairs, 78th Cong., 2nd sess. (Washington, D. C.: U. S. Govt. Printing Office, 1944), pp. 13, 18-19.

Where such differences are sufficient or can be made so by suitable exaggeration, it would be foolish for the seller to invent less substantial grounds for discrimination. Hence, it is usually impossible to classify differentiated products into two neat groups, of which one merely makes better provision for the varying needs of the consumer and the other merely affords excuses for discrimination in sales policy. Instead, both the artificial and the functionally natural differentiation of products may be used to support discriminatory pricing.

The second type, the differentiation of products through time, also has a dual nature. Some such differentiation is inevitable. Improvements in technology and changes in consumption requirements make it necessary to modify from time to time the characteristics of many products. Where product change proceeds by small and frequent alterations of particular features of appearance or performance, there may be no sharp distinction between the old and the new. However, to minimize the disruption of productive processes, it is common to avoid piecemeal alterations and instead to introduce many contemplated changes simultaneously by redesign of the product at regular intervals. Such a method of introducing changes creates a sharp distinction between the old and the new, and fosters a demand for the new by persons who already possess the old. However, in the durable goods industries the natural obsolescence of commodities is often too slow to permit the sale of new models in the desired volume. Continued use of serviceable old products delays the buying of new ones. To minimize this condition, new models may be differentiated from the old in appearance or performance to a greater extent than is technically required, for the sake of hastening obsolescence and thus enlarging the market for the new. Obsolescence of style is thus added to obsolescence of function.

But no sharp line can be drawn between change that merely reflects progress and change that is made to force old models out of use. The more eagerly new features are desired, the more effectively they make old products obsolete. Thus the effort to enhance obsolescence promotes product improvement at the same time that it fosters changes that are not really improvements and encourages sellers to exaggerate the virtues of whatever is new. Changes that are functionally desirable are blended with changes that are merely commercially expedient.

The third type of differentiation usually reflects a conscious effort by a seller to reduce the impact of the competition he encounters. If he can make his own line of products appear to be unique he is likely to enjoy, to some degree, freedom to set his price at a different level from the prices of his rivals, and is likely to retain his customers better if a rival sets lower prices or briefly makes special price concessions to attract business.[2] Since a desire for immunity from competition is general, the attempts of competitors to differentiate their respective products are likely to reinforce each other, each concern acquiring individuality not only by its own efforts at differentiation but also by those of its rivals.[3]

As in other kinds of differentiation, competitive differences in product are most strongly based when each product incorporates special features that are functionally significant in catering to particular tastes. However, as in other kinds of differentiation, not all differences have functional importance. Unimportant differences may be exaggerated and meaningless differences may be introduced merely for the sake of precluding a close comparison of the available alternatives. What is functionally significant and what is merely convenient to the seller may be blended together.

When significant and unimportant differences in the characteristics of commodities are blended and care is taken to avoid disclosure of the exact nature of the differences, intelligent choice by consumers is made difficult. The further the process is carried, the less likely it is that the consumer will pay only for such differentiation as, upon cool and well informed consideration, he might find worth its cost. Rather, to the extent that consumers are ignorant, gullible, and subject to persuasion, the total extent of ostensible differentiation of products may be expected to outrun that which is appropriate to varying tastes and needs; or, if one prefers a different form of statement, the tastes of consumers may be molded to welcome differentiation in many respects in which no differentiation would have been desired but for the molding process.

THE RELEVANCE OF STANDARDS

Each of the three types of product differentiation is likely to involve a lack of uniformity in the physical characteristics of commodities, and is thus likely to run counter to the requisites of mass production. The techniques of mass production are those of breaking down the productive process into a series of sharply defined standard operations. It is the repetitive uniformity of each operation which makes possible the extension of the machine process, the specialization of labor, and the centralization of control. But an operation which is standard and repetitive becomes possible only if it is to have a standardized effect upon each successive unit of the commodity subjected to it; and a commodity which takes its form through a standard series of such standardized effects is necessarily a standard commodity. Within a single plant the standardization of the goods produced by a series of productive processes is prerequisite to the standardization of those processes and to the mass-production techniques that accompany such standardization. Differentiation of products within a single plant requires either a partial abandonment of mass-production methods or the setting up of two or more different mass-production processes alongside each other.

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[2] When such differentiation of product is believed by the buyer to be important, it may give the seller an immunity from competition which is comparable to that of a monopolist; and the availability of other differentiated versions of the same commodity may limit this immunity only in the sense that the availability of substitutes limits monoply power. The release from competitive pressures can be roughly estimated from the spread in the prices of differentiated goods. For example, various nationally advertised brands of drugs and cosmetics continue to be bought widely at prices much higher than the prices of substantially identical private brands. In a recent advertisement of private brands in *The New York Times* (May 3, 1955), the aggregate private brand price of the first ten items listed was slightly less than 53 per cent of the aggregate list price of equivalent nationally advertised brands.

[3] The only important exception appears in cases where a company has established a reputation for high quality and then finds itself exposed to imitation of its products by rivals who have no equivalent reputation. In these cases, each effort to differentiate leads to a new imitation and each imitation to a new differentiation, so that instability through time appears as an unplanned feature of the competitive conflict of policies.

The differentiation of products from plant to plant and from company to company is likewise inconsistent with full mass production, although the inconsistency is less obvious. If each unit of one plant's output is the same, mass production within the plant may be unimpaired by differences between the product of that plant and the products of other plants; but the lack of uniformity in the products supplied by different plants is necessarily reflected in some lack of uniformity in the materials and parts that are bought for the various plant operations or in the machines that are used in those operations. Thus the suppliers of materials, parts, and machines are prevented from standardizing their products and processes unless they are willing to sell only to particular designated customers. They are prevented from adopting mass-production techniques that would be feasible if their producer customers were making uniform products by uniform productive processes. The industry with differentiated products may achieve the internal economies of mass production but not the external economies of buying mass-produced components and equipment.

Similarly, the differentiation of products through time is a handicap to mass production. Where production is carried on by the close dovetailing of specialized mechanical processes, the introduction of a new model is likely to require a temporary shutdown and extensive retooling, both of which involve heavy costs. With a given degree of mass production, capital costs are enhanced by frequent and extensive change in models. In the effort to avoid excessive capital costs, an industry where changing models are to be expected may content itself with a process less mechanical and less closely dovetailed than might otherwise be economical.

Since the effect of the blending of functionally desirable differentiation with commercially motivated differentiation of the unimportant is that differences may outrun the requirements of consumer taste, it would be easy to conclude from the foregoing analysis that differentiation of products entails a substantial and unnecessary sacrifice of the potentialities of mass production. But the conflict of the two lines of policy is not as sharp as it appears to be. In practice there are various ways of minimizing the inconsistency between the logic of the market and the logic of mass production. For market purposes any form of differentiation which impresses the consumer is as good as any other. Therefore, apart from the truly functional differences, the methods of differentiation that are actually adopted in mass-production industries tend to be those which interfere least with the mass-production processes. A few conspicuous surface features of a commodity may be sufficient to differentiate it in spite of the standardization of the functional attributes that lie under the surface. Even the peculiarities of the surface may be limited to those that can be established at relatively low cost in a few special operations that do not interfere with the basic repetitive processes. Thus, in automobile production, axles, engines, and body surfaces may be much more nearly standardized than colors and accessories. Emphasis upon the relatively conspicuous and superficial elements that differentiate products may be coupled with an effort to wean the customer away from preferences for types of differentiation that would be seriously inconsistent with standardized production.

Where the product must vary in composition, dimension, or performance to meet the functional needs of consumers, it is sometimes possible to work out a standard series of gradations and to fit the variations to the standard scale. The mystery of commercial differentiation can be preserved in spite of such standardized gradations, provided the differences are of a technical character not readily understood by the consumer. Thus, for example, variations in octane rating and other measurable aspects of quality might enable a petroleum engineer to compare two brands of gasoline exactly, but apparently the use of such standard gradations does not prevent petroleum companies from establishing in the minds of the buying public a belief in special and mysterious qualities for particular brands.

Moreover, a considerable amount of differentiation can be established regardless of the physical characteristics of the commodity. Special packaging and a special name may be sufficient to create a special identity for cigarettes, even where laboratory technicians would be puzzled to find any objective difference. Indeed, there is reason to believe that a formal standardization of elements of quality and a specific disclosure of the facts is often insufficient to overcome the effect of the seller's sales effort upon the minds of most consumers. One large department store proclaimed in full-page announcements that all aspirin is required by law to be identical, but found that even across the store's own counter a well-known nationally advertised aspirin continued to sell well at about ten times the price of the store's private brand. Canadian canned foods, though grade labelled, are persistently advertised by brand name, and the well-advertised brands persistently sell at a premium.

Thus the conflict between differentiation and mass production proves to be narrower than might be anticipated from the divergent logic of the two types of policy. If functional differences based upon varying tastes are not too great, basic standardization and mass production can be preserved even for differentiated products. There is considerable probability that the commercially differentiated article will require departures from mass-production techniques in the parts of the productive process which determine the appearance of the commodity, and that standardization will be resisted as to elements of the commodity which might reliably identify its quality to consumers. However, even these features may be standardized if buyers are sufficiently ignorant and careless to be persuaded by mere assertion and reiteration or by the mere packaging of the commodity.

But even in cases in which only the brand name and the package are differentiated, the impact of the logic of the market is likely to limit the full effectiveness of the mass-production process. Containers might themselves be mass produced, and the differentiation of the container precludes one particular form of external economy. The special sizes and shapes of soft-drink bottles, for example, mean that such a bottle costs more than need be and that the industry, therefore, must give the consumer more bottle and less contents for his money. Moreover, the sales effort that is required to establish and defend a reputation and to sell a series of differentiated products is necessarily greater than would be needed to move the same volume of mass-produced identical commodities. A distributor who must be prepared to furnish a product in any of its differentiated forms must maintain a larger inventory than would otherwise be necessary, and must resign himself to a slower turnover of stock than he might otherwise achieve. Thus product differentiation is probably one of the factors responsible for the high cost of distribution which is often bewailed as a handicap to the full employment of mass-production techniques in manufacturing. When consumers pay more for the additional costs of differentiated selling and for the higher levels of price and profit which these costs are designed to establish, the total volume of goods moved is necessarily reduced and the employment of mass-production techniques correspondingly limited. The mass-produced goods also become obsolete more quickly because competing goods are given an exaggerated novelty by functionless differentiation through time. In markets where the attention of managers is focused largely upon the strategies of differentiation, attention is diverted from mass production, and the pace of development of mass production is likely to be retarded thereby. Some conflict between mass production and product differentiation must remain, regardless of efforts to reconcile the two.

One should be careful, however, not to interpret the conflict as a mere clash between a healthy technology and a commercial perversion thereof. Important as the economies of mass production are, not even the economist or the engineer, much less the consumer, would accept an economic system in which the vagaries of human nature must be fitted to the Procrustean bed of the machine process. Some variety is obviously worth its cost. Moreover, the search for variety may have useful aspects even if its motive is exploitative. Because businessmen can obtain advantages from differentiation of products, they are encouraged to experiment with product design and improvement; and such experiments are a part of a healthy economy. Moreover, the cost of attaining variety can be reduced by experiment. Because it is hard to differentiate products without impairing the efficiency of mass production, there is an incentive to find ways to make the mass-production process more flexible than it might otherwise be. Thus, for example, convertibility is emphasized as one of the desirable elements in machine design.

It is ironical, however, that the virtues of product differentiation are most apparent in those cases in which variety appears in relatively important functional characteristics of the product and in which, therefore, the diversity of products is least consistent with mass production. As the diversity becomes more superficial the mass-production process is less disturbed; but it is precisely in these cases that the exploitative element in product differentiation is largest and the differentiation itself is hardest to justify.

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31. STANDARDS AND RESOURCE CONSERVATION

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Civilization's Handicap Race with Nature

FIFTY YEARS ago the suggestion that the United States, believed to be the most richly endowed of all nations in the world, might face a problem of resource scarcity would have seemed fantastic. But the Paley Commission found[1] that while in 1900 American production of materials (other than food and gold) exceeded consumption by 15 per cent, by 1950 surplus had been turned into a deficit of 9 per cent, and that by 1975 the excess of materials imports (estimated in dollars of constant value) would exceed domestic production by 20 per cent.[2] Many strategic materials, both for peace and war, are involved:

> Of more than 100 mineral materials we use, about one-third—such things as sulfur, coal, phosphates, but including only two metals—are fully supplied from our resources. Another third of the list we get almost entirely from other lands, and this fraction has assumed greater importance as advances in the technology of high-temperature alloys and electronics have brought into greater prominence such items as columbium, cobalt, high-grade quartz crystals, and others we do not possess. The final third of the list we obtain partly from abroad and partly from domestic output—materials like iron ore, petroleum, copper, lead, zinc, and bauxite. Of 72 "strategic and critical" materials listed by the Munitions Board, the United States imports all of its supplies in more than 40, and part of its supplies in all of the rest.[3]

Furthermore, with rising standards of living, continued population increase, and steady advance of industrialization the rate of materials consumption rises cumulatively. This rise is greatest with respect to precisely the materials of most strategic importance to an expanding indus-

[1] *Resources for Freedom,* President's Materials Policy Commission (Washington, D. C.: U. S. Govt. Printing Office, 1952).

[2] *Ibid.,* Vol. 1, p. 2.

[3] *Ibid.,* p. 17.

trial system such as ore, minerals, and fuels. While population increased between 1900 and 1950 from 76 to 151 million, and per capita income from $325 to $864, demand for minerals (including all fossil fuels) rose sixfold. Use of bituminous coal increased 250 per cent; copper, 300 per cent; iron ore, 350 per cent; zinc, 400 per cent; natural gas, 2600 per cent, and crude oil, 3000 per cent. "Indeed," the Report goes on to say, "there is scarcely a metal or a mineral of which the quantity used in the United States since the outbreak of the First World War did not exceed the total used throughout the world in all the centuries preceding."[4]

As for the future, since use of these same minerals rises "twice as fast as [the] total of all other materials," it is important to realize that something like a geometric factor has been added to the demand for the "stock" or depletable resources. "Flow" or renewable resources, such as soils and forests, are capable of sustained yields, but "a ton of ore removed from the earth is a ton gone forever" and "each barrel of oil used up means one less remaining."[5]

But renewable resources "have also felt the drain." There are two principal reasons. On the one hand, exploitation in many instances is currently in excess of rates of growth, as with forests (saw-timber cutting exceeds annual growth rate by 40 per cent), and replenishment, as with the sardine and salmon fisheries of the West Coast and the herring fisheries of the North Atlantic. More serious, on the other hand, is man's action as a geomorphic agent, particularly with reference to loss of soil resources through wind and sheet erosion, leaching of chemical nutrients, and similar wastes. A careful study by the former director of the Taylor Society[6] rationally asserts "that in another century this great American granary may have become inadequate to support our population if erosion is permitted to continue at the present rate of increase."[7]

When, and by so much as we must, we turn to foreign materials resources, we face the problem of rapidly accelerating demand there also. Most of the world is now undergoing a "population explosion" which threatens to double the global population within from fifty to a hundred years. Simultaneously, most of these peoples are sketching out broad development programs for accelerated economic development in which rapid industrialization is generally entered as a basic component. Merely to bring the rest of the world up to the material standard of living of the

[4] *Ibid.*, p. 5.

[5] *Idem.*

[6] H. S. Person, *Little Waters, A study of headwater streams and other little waters, their use and relation to the land,* Soil Conservation Service, Resettlement Administration, and Rural Electrification Administration (Washington, D. C.: U. S. Govt. Printing Office, 1936).

[7] *Ibid.*, p. 30.

United States in 1950 would mean that "world need for materials would increase to six times the present already massive consumption."[8]

Hazards of war, and the requirements of massive peacetime defense preparations add further to the mounting scale of materials demand. According to the Paley Commission, "there were numerous cases in the last war where the military asked for much more than total available supply could provide, even after civilian uses had been cut to the bone or altogether eliminated."[9]

Such are a few of the leading reasons for growing concern with problems of conservation. But there is a final comment to be made. In many—possibly in most—fields, advances in technology seem to be running a handicap race with nature in which worsening conditions of extraction threaten industry with rising over-all costs of exploitation. As brought out in numerous studies,[10] in all major coal mining areas on the average the pits go deeper, the seams worked become thinner, and numerous other costs such as those associated with gas, water, and underground propping, tend to rise as exploitation advances. In petroleum, large oil finds decrease in number, the ratio of dry to producing wells tends to rise, the average drilling is deeper, and more oil must be pumped to the surface. Water power must come from more distant and less advantageously sited river flow. The richer deposits of iron and copper becoming exhausted, resort must be had to more distant deposits, or lower quality ores (e.g., taconites in place of the rich Mesabi ores). In the words of the Paley Commission, "In area after area the same pattern seems discernible: soaring demands, shrinking resources, the consequent pressure towards rising real costs, the risk of wartime shortages, the ultimate threat of an arrest or decline in the standard of living we cherish and hope to help others to attain."[11]

A Functional Approach to Conservation

Standardization may be of assistance in meeting the problems of conservation in a multitude of ways. A few of the more obvious ones may be cited: (1) Generally speaking, standards and specifications shift attention away from the properties of materials per se and toward the functions which materials (of whatever sort) are to perform. By so doing they promote materials substitution. By so much as this may lead to replacing demand for stock resources by flow resources it cuts down depletion, since it is of the nature of the latter that, properly managed, they may be maintained so as to sustain constant or even rising yields. Examples are synthetics and plastics based on wood and other agricultural fibers.

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[8] *Resources for Freedom,* Vol. I, p. 3.

[9] *Ibid.,* p. 17.

[10] For example, Eugene Ayres and Charles A. Scarlatt, *Energy Sources—The Wealth of the World* (New York: McGraw-Hill Book Company, Inc., 1952).

[11] *Resources for Freedom,* Vol. I, p. 1.

(2) The chemical revolution of our times is rapidly fluidizing the materials foundation of modern industry in such a way that, given an adequate system of specifications to use, cost changes which reflect scarcities may result in using many types of materials formerly unavailable or allowed, for one reason or another, to go to waste. From forest wastes, for example (roughly 60 per cent, by weight, of the average tree cut for timber is still not reclaimed) resins, alcohols, industrial sugars, and an astonishing variety of plastics for use in the making of furniture, dishes, components of durable goods, etc., may be produced. The same is true, of course, of the by-products of metallurgical, fossil fuel, and heavy chemical processing.

(3) Possibly of even greater importance is the fact that specifications tend generally to make "lean use" of any given resource. The aim being "best use" or functioning within the limits of current scientific and engineering knowledge, and with due attention being paid to all cost factors, the tendency is for standards to strip away superfluous types, shapes, varieties, and less economical and sparing methods of processing and using. On the one hand, no more and no less of the material need be used than the specifications state (making proper allowances, of course, for safety, quality control, and similar variables). For the defined use, enough is enough. On the other hand, standards of functioning require adequate performance. The first spares materials; the second makes them go further. Because both shift from less than optimum to optimum use of materials, both are conservation oriented.

Clearly, minimal standards which double the useful life of such commodities as leather goods and radio tubes cut in half the draft on materials resources for a given level of demand. They may, however, (4) do even more than this if woven in as components of standards that include all materials going into the shoe or the radio. With any commodity, from heaviest durable goods to lightest consumer goods, the life of the product tends to be as long as that of its weakest link. During the war, for example, in many cases a single breakdown rendered equipment entirely useless. Standards tend to rectify this weakness two ways: first, by evening up the strength of the weakest part to the average of all functioning parts, and second by making possible replacement of the broken or worn-out part from standard parts stocks. In both cases the correction of the part's shortcoming lengthens the usable life of the entire equipment, and thus reduces the amount of equipment needed for any given level of performance.

A like effect arises (5) from the drafting of standards of performance that enable buyers to discriminate against spurious obsolescence. The general tendency—most commonly found in, but not confined to, durable consumer goods—to build into equipment high rates of obsolescence, principally through model-izing in imitation of (principally) women's fashion goods, is clearly wasteful of resources. Attention is diverted away from genuine use and utility factors, and when that is the case goods may be scrapped before their useful life has been exhausted. Once this becomes common, design of goods and equipment in terms of the expectation of user obsolescence tends to follow as a matter of course. The result may then be mounting draft on materials resources for any given level of consumer use. Contrariwise, standards defining and directing attention to these very use factors are conservation oriented.

Again (6) it is obvious that standards are a precondition to, and are inseparably associated with, reorientation of both production and goods distribution on a mass output basis. Standards of some sort have eased the way for each of the several and more or less complicated steps which lead in production to the culminating achievement of automation—the completely automatic plant. Theoretically, as is already the case in steam and hydrogenerating plants and in most heavy chemicals processing, such a plant *can* operate 24 hours a day and 365 days a year. Thus, again for any given level of consumption, automation should require less plant (either in terms of physical plant or total investment) and hence fewer resources in the form of cement, lime, structural steel, glass, etc.

Theoretically also (7), since automation may be applied to any processing or manufacturing operation where an adequate system of standards exists for each and every dovetailed operation, it may produce for widening markets standardized goods which would cut the foundations from under the widespread practice of spurious product differentiation. That is, with the flow of standard products to the markets, both the *raison d'être* and the possibility of pretending that differences exist between branded, trade marked and otherwise designated goods when in fact they do not, are reduced if not entirely taken away. Price then tends to focus on real differences, buyer knowledge of the properties of materials tends to equate that of sellers, and the vast, swiftly growing, and superincumbent mass of costs associated with the promotion and vending of unimportant or nonexistent differences in a wide range of commodity lines tends to disappear. Bound up with the last are conservation gains which ramify endlessly throughout the economy: thousands of acres of forest otherwise going into supplying the mammoth demands for paper needed in such elaborate promotional work spared; warehousing facilities and retail storage space and physical inventories required for slow-moving stocks reduced; fewer L. C. L. (less-than-carload lot) shipments and hence fewer railroad cars to travel underutilized, etc. Standards in such cases should (a) save extensively on the absorption of materials required by this economic waste motion, and (b) redirect such resources back into lines of production which further advance material standards of living.

From considerations such as these one might go forward to discuss the countless ways in which standards reduce the costs of doing business. A large percentage of these reduced costs would be found rooted in the conservation of materials or resources. Thus, safety standards cut down losses of building and materials by fire, reduce accident rates which add to need for hospital beds, drugs, etc., to take care of the disabled, and heighten manpower efficiency. Standards of dimensions and shapes of processed materials cut down on new scrap, while standard classifications based upon simplified chemical formulae facilitate and widen the percentage of old scrap that may be economically recovered. Both sets of standards lead to economies on materials, fuels, equipment, plant, and manpower. Standards which promote palleting reduce the need for transportation equipment, tend to reduce the very costly volume of L. C. L. shipments, and thus also conserve fuels, roadbed, etc.

Countless other examples might be cited.

A Basic Component in the Larger Problem of Conservation

What such continuing citation of examples would sooner or later lead to is consideration of what Dr. Paul G. Agnew liked to call "the philosophy of standards." By use of the term "philosophy" he seems to have had in mind both the rationale and the bearing upon business and economic life as a whole of the rationale, which underlay the conception of specifications and standards as they are functional to use. After the introduction of standards scarcely any operation, product, or process would remain quite as it was before, and he saw few, if any, aspects of goods production and distribution—from the raw materials stages on through to use by the ultimate consumer—where standards could not make a constructive contribution.

With respect to the aspect of conservation, two examples from more recent works might be cited. In a very interesting study,[12] Ciriacy-Wantrup defines conservation as any policy or practice that tends, with any given pattern of resource utilization, to redistribute use over time toward the future. Depletion, contrariwise, redistributes them toward the present. Since all decisions relating to use of resources—whether by private individuals or firms on the one hand or by local, national, or international public authorities on the other—have a time reference which permits choice over the temporal distribution of use, nearly every business decision which involves planning for any considerable period of time has a resource depletion or conservation effect. Thus the state of business uncertainties, the level of interest rates, the nature of property relationships, tenancy, credit availability, taxation structure, the market form (competition, monopoly, etc.), stability of business, and many other variable factors have an identifiable relation to and bearing upon resource depletion and conservation.

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[12] S. von Ciriacy-Wantrup, *Resource Conservation; Economics and Policies* (Berkeley: University of California Press, 1952).

For example, property taxes tend to change utilization schemes in the direction of depletion because they encourage attempts to maximize returns now, while progressive income taxes, particularly if accompanied by low capital gains taxes, favor conservation. In this latter case, the incentive is high to redirect income upon which taxes must be paid now to development and further investment in future resources which build up future assets. Use, that is to say, is redirected toward the future; resources are conserved.

In Ciriacy-Wantrup's treatment there is scarcely a type of business or government decision which does not have some traceable effect upon resource conservation. By an analagous effort it might be shown that scarcely one of these resource decisions is devoid of a standards angle. To put the matter somewhat differently, it takes but little imagination to see that standards problems are scattered throughout virtually all the pores and crevices of an industrial system—indeed, of the society and culture as a whole. They will be found linked as an indispensable component with virtually any problem of production or distribution where interest lies in efficiency or economy—which is to say, in conservation.

Standards are linked up with economy and resource conservation in general, but they are also linked in a rather special way. While they focus attention upon function, best use, most efficient and economical methods, yet also the issues they pose are, as indeed they must be, increasingly resolved in an environment of scientific discussion, and in the light of scientific data. That is to say, they encourage what John Diebold has referred to in his book *Automation*[13] as "rethinking" through the fundamental problems of production and management. Such "rethinking" not only opens up the possibility of reorienting output upon an automatic plant operations basis, and thus helps to usher in what enthusiasts have referred to as the Second Industrial Revolution, but it also requires the redesigning of products, machinery, and plants in keeping with the rules and principles of specifications and standards drawn to use and function throughout.

Standards and prevention of waste are here but two sides of the same coin. Attention to one favors promotion of the other; neglect of either does damage to both. Yet also at the level of automation only the scale and

[13] New York: D. Van Nostrand Company, 1952.

intimacy of this interdependence is new. Each humble, detailed, and painstaking step taken over the years by the ASA in its thousands of committee meetings and in its voluminous records of standards formulation has caught and reflected a ray of that "philosophy of standards" of which Dr. Agnew spoke so eloquently, and each in its separate way has also made a contribution to the growing conservation-mindedness which is one of the outstanding developments of recent times.

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32. STANDARDS AND INTERNATIONAL RELATIONS

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IF IT IS DIFFICULT to achieve one's goal in the field of standards within a single country, the problems are greatly compounded when the endeavor is extended beyond national boundaries and an effort is made to achieve international standards. National boundary lines, arbitrary as they often are, frequently represent points at which substantial differences occur—differences in language, laws, currencies, standards of measurement, traditions, customs, and even philosophies. This is not to imply that within a single country differences may not exist, but rather to suggest that whatever they may be internally, they are likely to be magnified when one crosses a national boundary line.

So long as we were separated from one another by great distances, great when measured in terms of time, cost, and convenience, most of these differences were relatively unimportant. Two hundred years ago the North American continent was separated from Europe by a two-months' journey which could be undertaken only in small vessels and without the benefit of Dramamine. There were large areas in the world whose contact with the rest of mankind was exceedingly slight, if any. Today, the Atlantic Ocean can be crossed in a matter of hours in the air or a few days at sea. No areas, even the polar regions, are out of reach. If one wishes to do so, he can talk with people in most other countries directly over the transoceanic telephone. Distance is no longer a great barrier.

In this smaller world of ours, differences can be embarrassing and even dangerous. Problems may still emerge internationally even when standards or uniform practice have been achieved within countries. Within a country, uniform practices or requirements may have been a natural development of the fact that it was a single market, or they may have come from legislation made possible by the fact that the country was a national unit and authority presumably existed in the government to set standards. Internationally, there is neither the single market nor the central authority, and such standardization as has come about, has been largely the result of other forces.

Uniform Practices among Countries

To a large degree, the extension of standards beyond national boundaries has been a matter of absolute necessity in the transportation field. For example, if airplanes are to fly from country to country, it is obvious that safety requires international uniformity in regulations and in practice. Thus, if a pilot is approaching an airport in a strange country, he needs not only a common working language but common traffic procedures and signals.

Luckily, the postwar mushrooming of international organizations included one in the aviation field. Under the auspices of the International Civil Aviation Organization, fourteen sets of standards and recommended practices have been adopted and are in effect as annexes to the ICAO Convention. Standards have been established for:

1. Personnel licensing.
2. Aeronautical maps and charts.
3. Rules of the air.
4. Dimensional practices.
5. Meteorological codes.
6. Operation of aircraft in scheduled international air services.
7. Aircraft nationality and registration marks.
8. Airworthiness of aircraft.
9. Facilitation of international air transport (to simplify customs, immigration, and health inspection at border ports).
10. Aeronautical telecommunications.
11. Air traffic services.
12. Search and rescue.
13. Aircraft accident inquiry.
14. Aerodromes.

Each one of these annexes represents long international consideration of the problems involved, and covers many specific problems under the general heading. For example, the annex on rules of the air includes definitions of such terms as air traffic clearance, flight plan, and visibility; defines the aircraft to which the rules shall apply; sets standards for visibility; prohibits the use of intoxicants or drugs by crew members; establishes the authority of the pilot; prohibits dangerous acrobatic flights; provides rules for passing, overtaking, or landing, and for air traffic clearances; and provides rules for lights and visual signals. The annex on aeronautical maps and charts, filling some hundred pages, provides standard-sized charts and markings so that pilots all over the world will be flying by the same type of charts and all planes in the same locality will be using identical charts.

But aviation is not the only form of transportation calling for the development of standards. Many more automobiles cross boundary lines than planes, and they also have created international problems. These down-to-earth problems have recently been subject to international study at special conferences and particularly by the Transport and Communications Commission of the United Nations. The most recent development in this field is the preparation and submission to governments of a protocol to the 1949 Convention on Road Traffic (which came into effect March 26, 1952) setting forth a uniform system of road signs and signals, and an amendment to the same convention establishing criteria for the competence of motor vehicle drivers in international traffic. The earlier convention had provided for simplifying such difficulties as the general recognition in all the adhering countries of the driver's license and registration regulations of other countries. It also established maximum size and weight limitations for large vehicles and standard safety requirements with respect to lights, brakes, and traffic rules.

There are other areas of activity where international standardization has taken the form of adopting a common nomenclature or system of record-keeping. In the meteorological field, new universal meteorological codes for use in the continuous exchange of weather data went into effect January 1, 1955, a triumph for the World Meteorological Organization of the United Nations. For the meteorological observations themselves to be standardized, it became evident that the instruments used must fulfil the same requirements in all countries, and the latest development is of a new International Barometer Convention applied by all countries after January 1, 1955. Similar work has gone forward under the aegis of the International Telecommunication Union to standardize telegraphic operating procedures, including the development of an automatic alarm system for maritime radio telephony to make the receipt of SOS messages more certain.

One interesting effort in another field was that made by the United Nations, through the Population Commission and the Statistical Commission, to encourage the use of minimum standards in the some eighty national censuses taken during the period 1950-52. In various specialized cases—for example, aviation statistics—progress has been made in developing uniformity. In fact, under ICAO, agreement has been reached on the most desirable form and content of air transport statistical studies, so that information will be collected of general interest to all members and put in a form which will permit international comparison.

International Standardization of Military Equipment

The progress in establishing international standards illustrated above has been related chiefly to establishing uniform practices. To be sure, products have often been involved—lights on air fields, barometers, and signposts. However, the standards were set up less to encourage trade than to achieve some other purpose such as proper control of air traffic or better weather prediction. However, their relation to international trade is more than incidental. In the first place a substantial part of the activities which have been cited are related to the international movement of persons or goods. Obviously the greater the ease, safety, and convenience of crossing boundaries, the more international intercourse there will be. It must also be noted that these various efforts contribute in a broader way—they tend to reduce international friction and expand international habits of cooperation.

This same generalization—that efforts to achieve international standardization are frequently not directly concerned with the expansion of trade but may indirectly affect it—can be applied to the military field. In recent years, the North Atlantic Treaty Organization has tried to reduce the variety of military end-products with the obvious intent of making it easier to pool and interchange equipment, to reduce the size of inventories required, and to simplify production, training, and repair problems. In artillery, the U. S. 105-mm. piece has been accepted as standard by NATO, as have certain anti-gas equipment, three jet planes manufactured in Europe, the Canadian anti-tank shell, and two heavy tanks (one British and one American). The two tanks, incidentally, use the standardized screw thread agreed upon by the United States, Britain, and Canada.

The standardization of one piece of military equipment has reached virtually the highest diplomatic recognition. When President Truman and Prime Minister Churchill met in Washington in January 1952, the agenda was short, but in the listing of the half-dozen major issues to be discussed was the obscure item, "A Rifle." The joint communique issued at the end of the talks had this to say about this subject:

> We have reviewed the question of standardization of rifles and ammunition in the North Atlantic Treaty Organization. Neither country thinks it wise at this critical time to take the momentous step of changing its rifle. In the interest of economy, both in time and money, we have agreed that the United States and the United Kingdom will continue to rely upon rifles and ammunition now in stock and currently being produced. In the interest however of eventual standardization, we have also agreed that both countries will produce

their new rifles and ammunition only on an experimental scale while a common effort is made to devise a rifle and ammunition suitable for future standardization.[1]

This was only one more event in the long series of attempts to standardize the rifle and the caliber of small-arms ammunition. By 1950, the British had designed a new .280 caliber self-loading infantry piece to replace their fifty-year old .30 caliber bolt-action rifle. The Belgians also were working on one of similar design. The British suggested that the United States and Canada adopt their new design, and announced in the summer of 1951 that the new British rifle was going into production. The disturbed defense ministers of the countries chiefly involved met in August 1951, but were unable to find a solution. As noted above, the problem then went to the highest levels without resolution. The problem was partially solved in December 1953, when NATO adopted the .30 caliber rimless cartridge as standard. Shortly thereafter, the British Prime Minister announced that Britain would adopt the Belgian design .30 caliber self-loading rifle. He was immediately attacked by the Labor Party as being subservient to American pressure, but a motion of censure was defeated. However, the United States has not adopted the proposed rifle, and one expert has remarked that, "Standardization is still far off."

There are many elements entering into the problem of standardization of military equipment. As an interesting illustration of conflicting values, it is worth reporting that one argument in the United Kingdom against the new rifle was that the design would make necessary a substantial revision of that ancient glory of the British parade-ground—the manual of arms. In the past, the variety of national designs has undoubtedly been related to efforts to improve or differentiate equipment while the fact that inventories are usually large has tended to stand in the way of change once a design has been adopted. Odd calibers made captured supplies difficult to use by one's enemies and alliances in the past did not represent the building of an integrated military force with one's friends.

NATO, however, represents a new type of military operation. The parties have pledged themselves that they "by means of continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack." One of the high-level operations in NATO is called the Military Standardization Agency. Here again, the expansion of international trade is not the motive, although it may be a by-product. One objective of the standardization of military items is to permit production to be concentrated in particular countries rather than for each country to have to produce to meet its own needs according to some unique national specification. As a matter

[1] *The Department of State Bulletin,* Vol. XXVI (January 21, 1952), p. 84.

of fact, the kind of specialization now being developed in the military field represents an excellent demonstration of international trading as a means of permitting the advantages of specialization and comparative costs to be obtained.

Standardization in International Trade

The cases of progress which have been discussed above are ones in which the advantages of standardization seem to be clear, where there is an active international organization, and where action to achieve the objective lies in the hands of a small group. But what about the more normal products which are the materials, actual and potential, of which private commercial international trade is made? What is the situation for them?

It would seem to be an obvious conclusion that some goods which enter into international trade should never be standardized—those which express a particular culture or special skill, works of art and handicraft items being perhaps the best illustrations. Even here, however, one must be careful about generalization. Musical instruments may involve considerable variation, but it will undoubtedly be helpful that the International Organization for Standardization decided on October 21, 1953, that the tuning pitch for A in the treble clef shall be 440 cycles a second, and that musical instruments should be so manufactured that they are capable of being tuned to the standard frequency.

There are other cases where the problem is relatively simple, where standardization represents primarily a matter of establishing acceptable grades. Raw materials which move internationally such as wheat, cotton, sugar, coffee, and rubber must conform to a grading system in order for purchases and sales to be made. This need is usually met and enforced in the organized markets which exist for transactions in the various basic commodities. A large part of international trade relates to raw materials of this kind, and, therefore, there is much more standardization in foreign trade than is often realized.

There remains a vast number of items where differences are traditional. They may differ because they are built to the metric scale rather than to feet and inches. They may be related to different systems of measuring sizes—hats, shoes, or rivets. They may be constructed to use electricity on a different cycle basis. They may have been produced under different sanitary requirements or pharmacopeia standards. Each variation developed appropriately within its own country and market. There was nothing particularly right or wrong, efficient or inefficient, high cost or low cost about the nature of the differences. The character of the local product was literally the product of its environment. There is no problem about their application or use within their own country, but for one reason or another they are not adapted to use in other countries.

It is hardly necessary to point out that such a situation gives the businessman three choices. He may limit himself to his own market and try to find ways and means for keeping other producers away from it. Secondly, he may adapt his product for use in the foreign market, which may involve only using a label in another language, or a greater change such as putting the steering wheel on the right rather than the left. Third, he may try to eliminate or reduce the differences between the two markets.

If he decides to try to achieve some form of standardization, all the usual difficulties in achieving standardization within a country are likely to be present with the addition of at least two others. In the first place, the spirit of nationalism may take the form of an arbitrary and almost automatic resistance to change, particularly if the suggestion appears to have come from outside the country. Countries take pride in their differences.

Secondly, the existing unique practices within a country may have created and tend to maintain a protected market. Producers in other countries who might be interested in selling there would find it necessary to change and adapt their products to conform to the habits in the new market. It is obvious, therefore, that the pressure for adopting a universal standard would be related to the extent to which the domestic producers were content with a domestic market and the consumers were content with the products which they receive from the producers within the country. Thus, resistance to the establishing of international standards which would facilitate the international flow of goods becomes closely related to the whole issue of protectionism. In fact, national standards may be established for the usually unacknowledged purpose of keeping out foreign competition.

International trade consists of the exchange of goods and services among countries in which, like all economic transactions, both sides feel that they have benefited by the exchange. Since labor, natural resources, capital, skill, and engineering experience are not equally distributed about the world, it is clear that the more freedom there is for goods to be bought and sold internationally, the more efficiently the productive forces of the world will be used. Barriers which create limited markets are bound to encourage the less efficient use of resources. In fact, that is why they are there—to protect the less efficient (or unduly enhance the return to those who would be able to compete).

If goods were able to flow freely, at least the first stage in the development of uniformity, namely, confrontation, would take place. The producer who found himself having to make meaningless variations in his product because of national differences might work hard to reduce the dimensions of the variations. At present, the most important steps which need to be taken are those which will reduce the barriers to the flow of goods, and thus put economic competitive pressure upon these national differences.

There is much to be done in standardizing procedures in the foreign trade field. The United States, for example, has a tariff rate structure which is applied through a detailed system of product classification. Different rates of duty are based on such elements as materials used, value, size, or form. Many products can be included under several different categories, and some, particularly new items, have no clear-cut classification. The present state of confusion is indicated by the fact that in 1952, 14,205 cases involving classification were filed in the U. S. Customs Court, and 82,992 cases were pending at the end of the year. Many cases are on record where identical commodities entering in different customs districts received different classifications. One classic story relates to small pianos for use in nightclubs, which are reported to have been classified as "musical instruments," as "toys," and as "articles partly made of ivory." This kind of confusion may turn a seemingly profitable transaction into a loss for the businessman. It does not achieve any result corresponding to a planned purpose, but adds a shifting hazard to the process of importation. At least, we might try to standardize the conditions of import.

The problem of lowering barriers to trade involves political decisions wherever the barriers are government constructed. The fundamental issue lies in the fact that increased foreign competition may benefit the consumer, a widespread unorganized group, at the expense of the related domestic producers of the specific products involved. Such special interests have a great stake in the issue, and in the political world, intensity by a small group is able frequently to overcome a less intense interest spread over a much wider area. There are special groups involved on the other side also, namely exporters, foreign investors, and even taxpayers. However, to some degree, the benefits to these groups from increased purchasing power made available abroad as the result of increased imports are mutually exclusive, and none of them can plead the same direct benefit as the domestic producer can plead danger. Interestingly enough, this description of the issues and interests involved is strangely parallel to the problem as it often appears in the search for a national standard in some particular, where some specific interest fearing adverse consequences is able to prevent a development which may seem in the long run to be clearly in the general interest.

Barriers can of course stand in the way of much more than the exchange of goods, and the basic problem in international affairs is whether or not we want a world where protective nationalism provides the theme or where the goal is increased cooperation. This does not necessarily involve the effort to establish an international uniformity without room for variations to correspond to cultural differences. The lowering of barriers will give greater choice both as to how best to use a country's resources and to maximize its supply of goods and services for the ultimate consumer. This is a goal which requires action on many fronts. Government policies which restrict and hamper the international exchange of goods and services must be modified. In addition, the interchangeability of materials and products must be increased. One force which will contribute greatly to the latter goal is increased international standardization.

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33. TOMORROW'S AUTOMATION NEEDS NEW STANDARDS TODAY

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STANDARDS AS TOOLS OF INDUSTRIAL MANAGEMENT

THE KEY ROLE played by standards in the nation's economy must be familiar to every reader of this volume. Of the half-dozen most important social-economic developments of the past century and a half, two—interchangeability and mass production—are based on standardization. There is now an enormous literature on the indispensability of standards in the modern industrial process. There is, moreover, extensive documentation both on specific, measurable dollar savings that have been worked by the introduction of new standards and on the many broader benefits that arise from use of standards on an industry-wide or national basis. These savings and benefits range from smaller parts inventory and more continuous employment by manufacturing for stock to smoother production flow and reduced training time of employees.

Not so well or so widely understood, however, is the relationship of standardization to recent technologies, new industries, or new processes, including the new and important art known as automation. It is with the relationship between standards and automation that I am primarily concerned in the present essay.

To state the case at once, we in the standards movement believe that standardization is one of the cornerstones on which the industrial structure of automation must be built if it is to be built efficiently and effectively. We hold that standardization is more than a technical function used to achieve shorter setup time, faster processing, fewer changeovers, longer runs, and the other commonly recognized industrial virtues. We contend, rather, that standards are also a key element in management con-

This discussion is based in part on a much shorter piece by the author which appeared in the September 1954 issue of *Automatic Control.* The author acknowledges indebtedness to Dr. John Gaillard of the ASA staff for certain concepts and ideas expressed here.

trol, coordination, integration, and planning—and hence in the new concepts of production and the new control systems that make automation possible.

In 1947 John Gaillard, then staff engineer in charge of mechanical engineering projects for the American Standards Association, set down as the ASA doctrine this principle: "Thirty years of analytical study and practical experience have refined standardization to the point where it has become a sensitive automatic control device of industrial management."

It must be admitted that this is not the conception of standardization commonly held throughout American industry. It is, rather, a concept that is still as advanced in its area as the principles of process production and strip feeding are ahead of those of mass production and the processing of loose parts. The reasons for this date back to the second decade of the twentieth century.

Standardization became an important factor in the national economy as a result of World War I. The war produced the new demands of mechanized warfare. It brought about the decentralization of functions that accompanies mass production. As a consequence, the increased need for central coordination in industrial management followed. Then came a general surge in systematizing and expanding the application of industrial standards.

After the war there appeared to be infinite possibilities for successful application of standards to peacetime problems. The lack of interchangeability of screw threads, for instance, had been a major handicap in the United States during the war, when fuses often did not fit shells. Dr. P. G. Agnew pointed out in "Twenty Years of Standardization"[1] that two large American companies each lost $10 million on their early British and Russian contracts, largely because of rejection of materials due to lack of an adequate gauging system to control the accuracy of the product.

The situation had its counterpart in many branches of industry. When the national standardization movement was crystallized with the founding of the American Engineering Standards Committee (now the ASA) late in 1918, work began in mechanics and only gradually expanded into the other branches of engineering. Throughout the 1920's, the emphasis was definitely on such matters as dimensional standards; concentration on the optimum number of types, sizes, and grades of products; material specifications as a basis of purchase; methods of making acceptance tests for materials and apparatus; drafting room practice; definition of terms commonly used in specifications and contracts; and abbreviations and symbols. Projects of this kind led to compilation and tabulation of much data as material for national (and later international) committees of engineers to work on.

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[1] *Industrial Standardization,* Vol. 9, no. 10 (October 1938), pp. 229-37.

This approach led inevitably to the understanding of standardization that prevails today. In this concept a standard is a solution to a recurring difficulty—to a difficulty originally caused by lack of a standard or by the existence of conflicting standards. Thus the primary function of the standardizer came to be considered that of bringing order out of confusion by drawing up an agreed-on "one best way" of doing, making, or measuring a product or a process.

One of the nation's leading industrial scientists described and approved this viewpoint at an annual meeting of the ASA in the 1930's: "Where proper standardization has been delayed beyond the time when it should have been done, the very turmoil and chaos of the resulting situation almost automatically impels conflicting interests to seek a common meeting ground. Further, from the welter of confused experience there is much material that can be salvaged in the making of a standard."

Under these conditions, the business executive was naturally inclined to consider standardization as a technical function which could be safely entrusted to the experts in charge of the various departments in his company. It is true, of course, that the technical experts have more than justified the trust placed in them. They made application of the principles of standardization one of the outstanding characteristics of American industry, with benefits in price, quality, variety, and supply of goods that appear on every hand. But despite their remarkable record, and because they lacked the direction from management to do otherwise, they have for more than a third of a century applied standards almost solely as a remedy for existing conditions rather than as an instrument of industrial planning and industrial control. In total view, this is an inadequate and inefficient use of a valuable instrument.

Europe, which is far behind us in the application of standards techniques, has carried on pioneer work in the theory of standardization. A judgment by an English mission sent to study the organization of standardization in this country is significant. The various groups of the mission had much to learn and apparently profited by their studies. But the final analysis of the mission reported by *The Engineer* is as follows:

> national coordination of standards is not so far advanced as in most European countries. The application of standards in the United States is stated by the mission in its conclusions to be widespread, but by no means consistent. American industry, it is suggested, pays little attention to standardization on a broad basis . . . if no immediate advantages can be seen.[2]

This lag is not unusual and perhaps is inevitable in our type of democratic society in any purposeful attempt to achieve harmonious integration of human activity. No one knows this better than those who work in the standards movement. One of their common characteristics is patience. They are willing to wait—for time is their ally—and they do not expect miracles. Their tone was perhaps set for them fifty years ago when Frederick W. Taylor declared sadly, but without resentment, "You cannot persuade any set of men, employers or employees, to adopt the principles of scientific management immediately."

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[2] *The Engineer,* London, England, Vol. 197, no. 5118 (February 26, 1954), p. 301.

The standardization movement is entering a new era, and it is time to begin using this instrument creatively, to broaden the base of standards work, and to rethink the basic function of standards in relation to increasing automatic control in industry.

STANDARDS BASIC TO THE NEW MACHINE AGE

Predetermined standards are one of the basic requirements of an orderly transition from today's mechanization to tomorrow's automation. Our plea to American industry is to build a comprehensive, integrated set of true national standards now, in advance of need. The alternative is to build them later in order to unscramble a mess that should never have happened.

The use of standards to solve old problems, to reduce general confusion, to meet recurring difficulties—all caused by lack of adequate standards—is now more than ever obsolete. The proper function of standards is not to solve old problems but to prevent new problems from arising. It is to eliminate confusion rather than cure it. It is to prevent emergencies, controversies, and misfires from happening.

Above all, standards should serve as a built-in automatic control device by which management may plan its operations, decentralize its decision-making power, and speed the "response time" of the entire organization—that is, the minimum time that unavoidably must elapse between the moment at which an executive decision is made and the moment at which action is taken to put it into operation. Any recurring problem, the solution of which can be handed over to top management in the form of a standard procedure, will automatically cut down the time required for the company to respond as a working unit. Reduction of this response time increases the sensitivity of executive control.

In order to achieve this, industry must plan its standards in advance. Standards cannot be developed on short notice. They take time. They must, therefore, be prepared, whenever possible, before the need of their applications arises. Wherever standards are used for the purpose of planning for the future, the standards themselves must be available ahead of time and, therefore, obviously must be themselves planned.

In other words, industry must predesign its standards with some of the care that it uses to design its machines, or the manmade materials it feeds into the machines, or the products that emerge from them. Only by so doing can industry make effective use of new technologies, including that of automation.

No one in standards work believes this will be easy. As Howard Coonley and P. G. Agnew pointed out in *The Role of Standards in the System of Free Enterprise*,[3] it took a vast amount of technical study and many years of negotiation before a "ten horsepower motor" meant the same thing to all the firms that made and used ten horsepower motors—and the standardizing jobs ahead are far greater than that. The work, nevertheless, must and can be done. Fortunately, the foundation has been laid, the experience has been gathered, and the machinery for carrying on the work has been built.

One thing seems clear amid all the claims and counterclaims, doubts and disputes about the new science of automation. The automated plant and industry will still be a closely integrated segment of our national economy, which is the most interdependent in the world. National standards of dimension, definition, performance, testing, and safety will be of capital importance to successful automation.

Standards permeate so many phases of this new science so deeply that it hardly seems feasible to list them. The main objectives of automation, for instance, as listed in one trade publication, are cost reduction, increased uniformity of product, safer working conditions, higher output, less waste, and improved operations in plant and office. These have been the objectives of the voluntary national standards movement since its founding.

In the narrowest sense of the word "standardization," the marvelous machines of automation cannot screw a nut on a bolt if the threads do not match. They cannot mill a T-slot if the tool does not fit the holder. The concept of telegraphing spare parts simply by sending a formula to be fed into a machine on a tape is an exciting one; but the concept is useless if the tape does not fit the machine and if the manufactured part does not interchange with the part it is replacing.

In a broader sense, the operations of automation are themselves standardized. "Project Tinkertoy" has been called by some observers the first automated production system for electronic parts. There were two aspects to that program, both of them based on and made possible by standards. The first was to achieve a modular design for electronics—a design basis in which there was a standardization for a modular unit being produced. The second was working out a system of mechanization for the production of electronics making use of that modular design basis.

In the broadest sense of all, it is generally recognized that successful automation bears a direct relationship to economic problems to which standardization has always been the key. In the words of John Diebold:

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[3] New York: American Standards Association, 1941.

> The most important single limiting factor is the cost of taping. . . . Once properly taped or programmed, the machines can perform the same or a varying task repeatedly. Whether they can perform it *economically* depends in large part on the length of run in proportion to the cost of taping. . . . The size of the market will then become the decisive factor in limiting the extent to which automation is economical.[4]

It is elementary, of course, that standardization of product for one consuming public of one social class lies at the base of the American mass market; and that use of common standards by the cities and states has made our free national market possible.

There is, finally, in the case of the production equipment of automation, what Diebold calls "the basic conflict of custom-built versus mass-produced units." He states that in both computers and automatic control devices, "custom-built equipment is too expensive for general use; yet at the same time the dynamic nature of the market limits the degree of standardization that can be achieved in production equipment and thus in electronic control systems as well."

But such equipment *must* be standardized, mass produced, and sold at comparatively low prices if the medium-sized machine shops and subcontractors are to participate in, benefit from, and contribute to this new science of automation. Until this problem is resolved, automation cannot spread beyond the giant companies capable of making the large capital investment required.

Some indication that this can be done lies in recent action taken by manufacturers of heavy electrical power equipment. For some 50 years that equipment has been the perfect example of machinery that had to be custom built to special order. A decade or so ago various main component parts were made interchangeable on machines of different ratings. A few months ago, "mass production" of transformers to an American Standard began in ratings up to 10,000 kva. Manufacturers estimate that in the next three years about $100 millions' worth of these standard transformers will be bought by steel mills, automobile manufacturers, utilities, railroads and others, with savings amounting to about $10 million in that time.

Standardization of automation machinery need not wait 50 years; nor does it need to be completed within months. Builders of the machines for the push-button factories of tomorrow could well meet today to write standards for such basic component parts as bases, beds, columns, and mountings; for standard work heights and drive units; and specifications for the application of electrical, hydraulic, pneumatic, and lubrication apparatus needed for production facilities.

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[4] "Automation—the New Technology," *Harvard Business Review*, Vol. 31, no. 6 (November-December 1953), pp. 68-9.

Standards as Factors of Basic Importance Within the Economy

Thus far I have tried to demonstrate that the advance of automation will depend to a considerable degree and in a variety of ways on the advance of standardization. The idea was expressed by Peter Drucker when he stated a general rule concerning the way we advance production performance. He observed that we push back the limitations of production farther and faster as we apply more consistently and more thoroughly the principles pertaining to the system of production used.

That the principles of standardization can be applied farther and faster in this nation is a proposition no standards engineer is likely to dispute. There is a high degree of standardization in our economy, but we certainly have not realized any major portion of the potential benefits of full use of standards. After several decades of a formalized standards movement, we are only beginning to understand how to use national standards and what they can do for us.

The fact that there is much more to be won from use of standards techniques is easily demonstrated by a simple little exercise of logic. A saving made today as a result of standards represents a waste that was permitted yesterday. Such savings will continue to be reported in the future. It therefore follows that the savings reported tomorrow represent waste that is being permitted today.

A specific illustration of the benefits still to be gained from further application of standards was given in an address made by J. C. Garrett, president of the Garrett Corporation, to the 1953 convention of the Air Force Association. Mr. Garrett declared that thousands of complex components going into aircraft and guided missiles cause a "staggering" spare parts and cost problem. He reported that his company is making 250 different types of electric actuators, more than 350 different air valves and regulators, and more than 45 different cooling systems. He urged the Air Force to make a vigorous effort to standardize the complex components going into modern aircraft and claimed that "hundreds of millions of dollars" could be saved during an emergency if the numbers of these components were reduced by one-third.

To demonstrate further: during World War II, Chrysler and General Motors Corporations both set out to manufacture a Pratt and Whitney airplane motor. Each company studied the blueprints from which the engine was being produced, and found them so different from those made in their own shops that each took an engine, tore it down, measured every part, and drew a set of blueprints on the basis of the measurements. For lack of simple, basic standards for industrial blueprints and drawings, the same happens today, and will continue to happen until industry writes the necessary national standards.

Lack of such standards hampers the whole relationship of prime contractor and subcontractor on which American industry is built. It is the reason why, in the words of Senator Ralph E. Flanders, "We lost the services of thousands of small companies which would have participated in war production if there had been a comprehensive system of national defense standards to which they were accustomed to work. Others would have participated more effectively." This represents a failure of elementary communications which we can ill afford in a dangerous world.

A similar condition prevails with respect to selection of sizes, measuring gauges, and tolerances for cylindrical parts. The tables now available are few, incomplete, and not always clear-cut. American industry—and particularly small industry—needs a complete and up-to-date national system of cylindrical fits. It needs an adequate guide that would help the engineer to select the basic sizes, and the allowances and tolerances, determining the fit between two mating parts best suited to his particular purpose. This is one of the fundamental standards underlying an effective scheme of mass production in the mechanical and related industries; but, except for a standard for a jig borer, there is not a single national standard in America today for master tooling.

As in the case of blueprints and drawings, large issues are involved—the issues of communications, of plant dispersion, of making full use of subcontractors, of the waste involved when designers order tolerances unnecessarily close for the work involved. Small companies cannot afford to draw up their own tables of recommended limits and fits. A standard national table would, among other things, substantially reduce engineering and drafting time.

Committees of experts have been working on both these problems under the auspices of the ASA, but progress is slow and probably will continue to be slow until top management gives the command decision to settle differences and integrate standards among different industries.

There are several basic American Standards relating to electrical recording, indicating, and measuring instruments. At the request of the American Society of Mechanical Engineers, the ASA called a conference in April 1954, which voted to develop "terminology pertaining to automatic process control, feedback control, regulating and related systems not requiring human intervention as part of the regulating procedure." The conference was attended by twenty-six persons (exclusive of ASA staff members) representing nineteen organizations. Among these organizations were the American Institute of Electrical Engineers, American

Society of Mechanical Engineers, National Electrical Manufacturers Association, American Petroleum Institute, American Society for Testing Materials, Instrument Society of America, Scientific Apparatus Makers Association, American Society of Refrigerating Engineers, U. S. Bureau of Ships, Department of Defense, Institute of Radio Engineers, the Chemical Industry Advisory Board, Electric Light and Power Group, and the Telephone Group. Sixteen other organizations were invited to designate representatives as working members of the ASA committee. All standardization efforts begin, or should begin, with definition of terms. Thus a good groundwork is being laid in an industry that is of first importance to automation.

Automation is in a transitional phase as is our entire system of production. In the early course of this phase, new processes, new products, and whole new industries are springing up, pushing back our horizons into new worlds. There is an opportunity here to do what we have never done in America before: to standardize in advance of need, to use standards according to their proper, creative, preplanning function, instead of as correctives in serious trouble.

Who is to pay for standardizing automatic equipment? American industry can pay the bill through the ASA to which it contributes a half million dollars a year to serve as a central, independent, mutually-supported clearinghouse in the writing, promotion, and use of standards.

Who is to bring together the machine tool builder and the special control engineer? The ASA provides an umbrella under which both can meet to discuss and solve their standards problems. The only requirements are that they meet also with all other groups substantially concerned with the particular standards; that they reach an agreement by consensus and consent; and that the standards they write be observed on a voluntary basis.

The industries concerned with automation can, if they will, use this machinery and these procedures to build their own industry standards and—what is even more important to them in the long run—national standards acceptable to government, the public, and other industries.

Such a set of fundamental national standards will help our companies, our industries, and our entire economy to win "the battle of technological margin" that is aproaching.

It will produce a spurt in productivity and help to compensate for the shortage of labor.

It can help the smooth introduction of automation processes, and assist management in meeting new problems that will be infinitely greater and more complex than any it has known before.

It will integrate the work and the product of the nation's 240,000 manufacturing companies and improve the infinitely complex relationship of prime contractor, subcontractor, and supplier.

It can ease the mechanical complications of daily living by making things fit; by making things work; by making repair parts interchangeable, simple, and accessible; by breaking bottlenecks; by reducing the number of misfires, delays, and misunderstandings; by causing words and symbols to have the same meaning for all of our people everywhere. If we do not control the mechanical complexities of the coming decades, they could add up to frustration, annoyances, and net inefficiency.

The first meetings of the small group of engineers who came together in 1918 to found a national standards organization were presided over by Dr. Comfort A. Adams of Harvard, then head of the American Institute of Electrical Engineers. At one of those meetings Dr. Adams declared:

> I think you cannot fail to see the tremendous possibilities and value to all industries, and to the nation as a whole, of this work of standardization. If we can inject into other organizations the idea which we have evolved here—the idea of thorough, broad, and comprehensive cooperation in the making of standards, then I think we will have accomplished one of the biggest jobs that has ever been undertaken in this country. It would do more to solve some of the present economic problems of the United States than anything else we could do.

Those words were profoundly true when they were first spoken. They are as true today. They hold no less truth for the new age that lies ahead—the Age of Automation.

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